Dear Readers,

From Thomas Jefferson to Benjamin Franklin, America’s founding fathers shared a fascination with science, experimented with and explored their environment, and applied their knowledge to the creation of technology. They were at once practical and political, visionaries and builders. They were not unlike the Old Dominion University scholars who figure in this issue of Quest. Avid readers themselves, they would have enjoyed, as I am sure you will, the broad range and depth of thought and research summarized in these pages.

We all recall the story of Benjamin Franklin with his kite and the lightning. He would certainly have been fascinated to learn what Richard Nuccitelli and Karl Schoenbach have accomplished with ultrafast pulses of electricity. They have brought about the remission of melanoma tumors in mice, which constitutes a significant step toward treatment of cancer in humans without surgery or drugs.

At the same time, Mounir Laroussi has used electricity to create a cold plasma pencil that can eliminate germs and bacteria. This device emits a plume of plasma that can clean wounds without harming healthy tissue. It can also be used for dentistry.

George Washington, who sought wealth from the land, would have appreciated the work of Patrick Hatcher, one of the nation’s leading organic and environmental geochemists. His new laboratory features an impressive array of equipment including a 12-Tesla Fourier transform ion cyclotron resonance mass spectrometer. Old Dominion University is one of only two universities in the country to possess this powerful spectrometer.

Old Dominion’s nuclear physics research group, Mark Dorrepaal’s mathematical models, and Alex Pothen’s computational work (and $7 million grant to establish the Combinatorial Scientific Computing and Petascale Simulations Institute with the collaboration of researchers from Sandia National Laboratories, Argonne National Laboratory, Ohio State and Colorado State) would have received much respect and applause from our founding fathers, who lived in an age when philosophy included the sciences, and mathematics was regarded as the most noble of sciences.

Phil Langlais’ work on the teaching of ethics and the establishment of professional standards in graduate programs across the nation would have been deemed honorable and necessary by our forebears.

Jefferson, responsible for Lewis and Clark’s expedition and for expanding America’s geographic boundaries, would have been delighted by Glen Sussman’s book, “American Politics and the Environment.” Professor Sussman calls for American leadership on global issues such as population, biodiversity, loss of habitat, freshwater supplies, energy sources and climate change, and our forebears would have applauded the thought of America leading the world. They would not have been surprised by the environmental concerns, as some natural resources of the Old World from which they came were already depleted.

Stacey Plichta’s study, which will help improve the way Virginia emergency departments and private doctors assist victims of sexual abuse, has a direct, practical application that would have pleased the founding fathers, who were concerned about health and health care.

Following a fine American tradition, the researchers at Old Dominion University have pushed back boundaries—whether physical, philosophical, practical, political or scientific—in order to serve the world. When Jefferson designed a university or Franklin imagined a system of education, they wanted to support the progress of the human mind and spirit, to promote an educated populace in support of democracy and economic development, to discover new ideas and possibilities for improving the lives of Americans. Certainly, this is what our scholars have accomplished.

I thank them for their outstanding work and for inspiring young scholars to emulate them.

Sincerely yours,

Roseann Runte
President
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MINIATURE LIGHT SABER IS TOUGH ON GERMS

MOUNIR LAROUSSI INVENTS A HANDY COLD PLASMA DEVICE

BY JIM RAPER
Most of the electronic instruments in the laboratory of Old Dominion University researcher Mounir Laroussi are gangling and custom-rigged to accomplish mind-boggling tasks.

But the homemade device that is his latest claim to fame is a plain-looking cylinder about the size of an electric toothbrush. He sometimes calls it the plume. Others called it a miniature light saber. The name that seems to have gained the most traction, however, is simply “pencil,” as in plasma pencil.

After Laroussi went public with his invention of the pencil in the summer of 2005, the device’s ability to kill germs without harming healthy human tissue was noted in several scientific publications, as well as in the February 2006 issue of National Geographic magazine. Representatives of private industry from the United States, the United Kingdom, France and Switzerland have made contact with him—and several have visited Norfolk—to inquire about commercial rights to the pencil.

“The interest pleases me,” he says, “and I am pleased by how far our small plasma community has come.” During the past decade he has been a leader in the development of the so-called “cold” plasma, and of the use of plasma technology in biomedical applications. Nevertheless, like any pioneer, he has had some moments of frustration and uncertainty during his quest to turn an original idea into marketable products.

When Laroussi was growing up and beginning his education in his native Tunisia, the only plasma he knew about was blood plasma. During his doctoral education and postdoctoral work in electrical engineering at the University of Tennessee, however, an altogether different plasma grabbed his attention. This type of plasma is a soupy cloud created when some sort of energy, such as extremely high heat, rips electrons away from the nuclei of atoms.
Think of H\textsubscript{2}O energized so that it progresses from ice to water to steam, and, finally, to plasma, which some scientists call the fourth state of matter. Plasma can emit light of different colors and conduct electricity. The sun is mostly a superheated plasma and so is lightning. Neon gas contained between electrodes produces plasma that lights up the lettering and logos of neon signs. A field of plasma cells glows in precise colors to create images on plasma television sets. Jets of plasma can etch silicon chips, or can treat surfaces of potato chip packages so that ink or paint sticks more readily to them.

Cold plasma proves useful

Laroussi’s “plasma-heating” experiments at the University of Tennessee in the early 1990s were in support of attempts to create energy by fusion—in a manner similar to how the sun produces heat and light. He also studied ways to change surface properties of polymers. These initial experiments involved plasmas activated inside a vacuum chamber, because at normal atmospheric pressure the plasmas are too hot and aggressive to use.

“But, doing everything under vacuum is very tedious, and we wanted to move outside the vacuum chamber and into normal pressure,” he said. By trial and error, including the use of ultrarapid pulses of electricity, Laroussi was able to turn gases at normal atmospheric pressure into “cold” plasmas. He quickly moved to the head of the class in his field of research, and became known for his ability to produce an abundant amount of cold plasma economically.

In cold plasma, electrons are wildly excited but they are so light in weight that they produce little heat. Heavier ions in this particular soup are relatively unexcited and so they also produce very little heat. Although much less aggressive than conventional plasmas, the cold plasma that was the subject of Laroussi’s research retained enough potency for many industrial tasks, while having a significant ease-of-use advantage over conventional plasma.

“Then one evening I was home, and probably bored, and I began to wonder what I could do with plasma next,” Laroussi says. “I started thinking about treating surfaces, not in order to affect the surfaces, but to affect the biological materials that may be on the surfaces. I guessed that the plasma would have an effect on cells. That was 1994.”

The very next year he presented his first research paper on the capabilities of plasma to kill bacteria, as might be used in sterilizing medical instruments. (Sterilizing with heat can ruin delicate instruments and chemical disinfection can leave problematic residues.) “I wanted very much to publish my findings, but I worried that the editors of a plasma journal may not accept a paper that mixed plasma findings and biological findings. They might ask, ‘What do the two things have to do with one another?’”

Nevertheless, he got the paper published in the Institute of Electrical and Electronics Engineers’ journal, Transactions on Plasma Science, and then set his sights on slipping the topic of biological applications of plasmas into one session or another of the IEEE’s annual International Conference on Plasma Science. “The problem was, these sessions were set up rather rigidly and biological applications research was so new,” he says. Laroussi finally worked out an agreement with a colleague who ran a session on microwave-plasma interaction. “He would break his session into two and let me be chair of one half of it,” Laroussi says. “That was 1998. I remember well, the conference was in Raleigh, N.C. We looked all over and found only three papers on biological applications. So much has changed since then. We have gone from having to sneak half of a session into the program to having the biological applications session be the largest or among the two largest each year at the conference. Today every international conference on plasma science includes a session on biomedical applications.”

“I started thinking about treating surfaces, not in order to affect the surfaces, but to affect the biological materials that may be on the surfaces.” MOUNIR LAROUSSI
Also during the closing years of the 1990s, Laroussi set up what has been a lasting funding relationship. Many research funding agencies, he says, "were a little skeptical" of biological applications of plasmas, "but the one who really believed in its potential was the Air Force." He describes Robert Barker, the program manager for plasma physics at the Air Force Office of Scientific Research, as a "visionary."

**From Tennessee to Norfolk**

The year 1998 was important for Laroussi for another reason; that was when he decided to come to Old Dominion. The person most responsible for luring him to Norfolk was Karl Schoenbach, eminent scholar and professor of electrical engineering at ODU’s Frank Batten College of Engineering and Technology. By 1998, Schoenbach had built a steady reputation in bioelectronics research. "He encouraged me to come to ODU because we are going to try to form a center devoted to bio-inspired research," Laroussi says.

The Frank Reidy Research Center for Bioelectronics did come to pass in 2003 as a collaborative endeavor of ODU’s Batten College and Eastern Virginia Medical School. The facility is located four miles from the ODU campus in the City of Norfolk Public Health Building. Schoenbach, who now is the Batten Chair in Bioelectronics Engineering, is director of the center.

Even before the center opened, however, in 2001, Business Week magazine named Laroussi and Schoenbach as experts in the new field of cold plasmas, and both men had begun to create a stir internationally with their research involving electrical-pulse technology; he holds four patents in the field. But his main quest and he has built several other devices that apply plasma technology, such as cold plasma generators, which created a cloud of plasma between two electrodes that were no more than a couple of inches apart. "We needed to get the plasma out where we could access it," he explains.

While he was working on his ideas, other researchers produced devices smaller than a breadbox that could shoot out plasma plumes less than a half-inch or so. But these devices tended to be hotter, unwieldy, unpredictable and unsuited to prolonged use because of overheating. Laroussi wanted true portability, he wanted a genuinely cold plume that could be tuned to lengths between 1 inch to 2 inches, and he wanted reliable usage for up to eight hours at a time.

"I always go back to the saying of Thomas Edison," Laroussi says. "He said that invention is 1 percent inspiration and 99 percent perspiration. That is the way it was with the plasma pencil. Edison was 100 percent right. We tried many ideas, changing materials and et cetera, day in and day out, and finally one day we hit everything right."

Xin Pei Lu, a postdoctoral researcher at the Reidy Center, assisted Laroussi during the testing of the various versions of the device.

Right out of the chute last summer, the pencil was lauded in scientific publications and other national media for its potential uses, including killing plaque- or infection-causing bacteria in the mouth, disinfecting wounds and sterilizing tools.

**More research is needed**

Follow-up research in early 2006 supported predictions that the pencil could be useful to dental and medical professionals. Together with Wayne Hynes, ODU associate professor of biological sciences, and Gayle McComb, ODU associate professor and director of the Dental Hygiene Research Center of the Gene W. Hirsfeld School of Dental Hygiene, Laroussi’s research group did extensive tests of the plume’s effect on various organisms under various sets of conditions.

"We have seen that the pencil is able to affect the growth of a number of different organisms, including some spore-forming organisms," Hynes says. "When bacteria are spread on the surface of a nutrient media and then exposed to the pencil plasma plume, the growth of some bacteria are inhibited. We are currently expanding our screening to determine what organisms are inhibited by the plasma, and trying to determine the conditions needed to inhibit growth of different organisms."

Hynes, whose comments about the research were made in spring 2006, believes that the pencil has potential to be used by dental professionals to treat bacterial infections of the mouth. "A number of conditions still need to be sorted out before we can predict if that is going to be the case, but it seems possible."

Addi McComb: "It is our hope that the cold plasma research will ultimately lead to technology that can be used in dentistry as a cost-effective, efficient way to reduce or eliminate oral and environmental pathogens that cause disease."

Another round of research just under way in spring 2006 pairs Laroussi with Fred Dobbs, ODU professor of ocean, earth and atmospheric sciences, whose primary expertise is in marine microbial ecology. A grant from the Air Force will allow the researchers to learn more about how cold plasma impacts complex eukaryotic cells such as mammalian cells.
Every time Laroussi passes his hand in a slow sweep through the plume of the plasma pencil he illustrates what seems to be an important characteristic of the device: although a brief burst of cold plasma plume can zap various types of simple prokaryotic cells (such as bacteria), the same burst tends to have no significant effect on the complex eukaryotic cells that make up human tissue. Through these latest experiments, Laroussi and Dobbs hope to provide more evidence of the pencil’s ability to kill bacteria inside the mouth or in an open wound without damaging healthy tissue.

The researchers also want to obtain data that will indicate whether cold plasma treatments can be devised to attack certain eukaryotic cells—such as cancer cells—or to remove dead tissue and accelerate healing.

Laroussi says other studies have shown that eukaryotic cells are protected from a plasma assault because their DNA and other essential components are protected by inner membranes. Prokaryotic cells, however, have only outer membranes and free-floating DNA. He theorizes that the upcoming experiments by him and Dobbs will show that the jet of the pencil can blow out the outer membranes of prokaryotic cells and cause internal damage that is not so easily accomplished with eukaryotic cells. (The pencil’s jet is produced from a neutral helium medium, but is peppered with highly reactive oxygen atoms that can kill prokaryotic cells.)

Zohir Handy, the ODU licensing manager in the Office of Research, calls the pencil “a sexy appliance that is getting a lot of attention from industry,” and says that any studies showing its safety and the extent of its usefulness in medicine and dentistry will make it even more attractive for commercial development.

“Thomas Edison . . . said invention is 1 percent inspiration and 99 percent perspiration. That is the way it was with the plasma pencil. Edison was 100 percent right.” MOUHIR LAROUSSI

The plasma pencil was featured in the February 2006 edition of National Geographic and he was interviewed about his work on The History Channel.
Even before the Frank Reidy Research Center for Bioelectrics opened in 2003, researchers from the sponsoring institutions, Old Dominion University and Eastern Virginia Medical School, had reported that they could reduce the size of tumors with nanosecond-range pulses of electricity.

Then, early in 2006, the researchers served up findings that were even more promising. In a paper published in March by Biochemical and Biophysical Research Communications, a Reidy Center team reported that pulses of electricity shorter than a millionth of a second cause complete remission of melanomas on the skin of mice.

The researchers found that ultrafast pulses with field strengths ranging as high as 40,000 volts/cm can cause the skin tumors to self-destruct. Following this treatment, tumor cell nuclei shrink by 50 percent within minutes and the tumor blood supply is disrupted for weeks. The paper also suggests that tumors inside the body may respond to a similar treatment delivered by catheter electrodes.

Richard Nuccitelli, a biophysicist on the Old Dominion faculty and a researcher at the Reidy Center, believes the results are an important step toward human cancer treatments that involve no drugs and produce no lasting side effects. The paper notes that the pulsed electric field also seems capable of curing skin cancers without causing the scarring left by surgical incisions.
Research seen as promising

“We see these results as very important,” says Nuccitelli, first author of the paper. “We want to continue the research to learn more about how the pulses work.”

James Weaver, a senior research scientist for the Harvard-MIT Division of Health Sciences and Technology, told The Virginian-Pilot that the Reidy Center researchers are in the forefront of bioelectric research. “People have known for a long time that certain kinds of big electrical field pulses can kill cells,” he was quoted as saying. But, he added, the latest findings advance hope that tumor cells can be killed without damaging nearby cells. “I think it’s going to attract a lot of attention.”

In late March, just a week after publication of the paper, the National Academy of Engineering announced the Reidy Center’s findings on a radio broadcast it produces for WTOP in Washington, D.C. A transcript of the broadcast was posted on the NAE Web site.

Another of the paper’s authors, Karl H. Schoenbach, is director of the Reidy Center and a leading expert in the new field of intracellular electromanipulation. A professor and eminent scholar of electrical and computer engineering, Schoenbach also is Batten Endowed Chair in Bioelectrics Engineering at Old Dominion.

Earlier papers from Schoenbach’s research group described pulsed electric field experiments that destroyed cancer cells through apoptosis—an orderly self-destruct mechanism. Two of his collaborators in the earlier research, Stephen J. Beebe, EVMS professor of physiological sciences and pediatrics, and Juergen F. Kolb, ODU assistant professor of electrical and computer engineering, are also authors of the latest paper. R. James Swanson, ODU professor of biological sciences, and two ODU graduate students, Xinhua Chen and Wentia Ford, are also authors of the paper.

The nanosecond-range electric field pulses produce remarkable effects compared to longer pulses because of the field’s penetration of the outer cellular membrane. Membranes typically resist penetration by electric fields, but the ultrashort pulses, lasting only 300 nanoseconds or 0.3 milliseconds of a second each, essentially sneak through before the outer membrane can mount a defense. Once inside the cell, the electric field is able to act upon the nucleus and other intercellular organelles.

Some tumors required two treatments

Soon after the pulsed electric field penetrates tumor cells, the nuclei shrink—possibly because of DNA damage—and blood supply to the melanoma is cut off, according to the researchers. In a study that lasted more than a year involving the treatment of 300 tumors on 120 mice, the researchers consistently were able to shrink melanomas by 90 percent within two weeks of initial treatment. Pulse applications to the tumors varied in length and staging, but generally comprised a series of pulses with a total duration much shorter than the blink of an eye. The researchers report that after two weeks, melanomas began to regenerate, requiring a second treatment before complete remission was accomplished.

Because of the short duration, the pulses cause no significant heating of the tumor; researchers also observed no lasting damage to healthy cells surrounding the tumor. Schoenbach predicts that cell electromanipulation “will end up in your doctor’s office” with applications not only for tumor treatment, but also for gene therapy, wound healing, removal of warts, treatment of fungal infections and other cosmetic uses. “The effects that have been observed so far are only the tip of the iceberg,” he says.

Largely because of the work of Schoenbach and Beebe, Old Dominion administers a multi-university consortium for bioelectrics researchers representing the Harvard/MIT Division of Health Sciences and Technology, University of Texas Health Sciences Center, Washington University, the University of Wisconsin, as well as the Reidy Center. Old Dominion also is involved in international bioelectrics collaboration, having established a consortium for bioelectrics with Kumamoto University in Japan and Universitat Karlsruhe in Germany.

Not long after the startup of the Reidy Center, Schoenbach recruited Nuccitelli, who served on the faculty of the University of California, Davis, for 23 years before retiring in 2000 to begin his own biotech company.

Nuccitelli’s experience with a mouse/melanoma research model led Schoenbach to suggest the experiment that resulted in the latest paper. “In the very first experiment, the tumors shrunk dramatically,” Nuccitelli says. “I was, to say the least, excited. But we also wanted to be 100 percent sure. We followed up on 300 tumors, and every single tumor responded. We have established a high degree of accuracy for the findings and documented them with four different imaging techniques.”
New design improves results

Electrical pulses were delivered to some tumors via needles, but the researchers found it difficult to obtain uniform field coverage of the tumors. Another of the paper’s authors, Uwe Pliquett, a German engineer who was a visiting scholar at Old Dominion last year, designed tiny parallel plates that delivered the pulsed electric field to melanomas pinched between the two plates. This technique provided a uniform field and produced better results.

Researchers at the Reidy Center were planning experiments in the spring of 2006 to determine if a mouse can survive a melanoma and still be healthy four to six months after treatment, as well as further research to explain how it is that nanosecond pulsed electric fields impact both diseased and healthy cells. Nuccitelli says experiments on higher mammals may be required before the researchers turn to human subjects.

The melanoma research was supported by grants from the Air Force Office of Scientific Research, American Cancer Society, Old Dominion University Educational Foundation, BioElectroMed Corp., a gift from Frank Reidy and with internal funds of the Reidy Center.

“(Cell electromanipulation) will end up in your doctor’s office. The effects that have been observed so far are only the tip of the iceberg.”

KARL SCHOENBACH

“In the very first experiment, the tumors shrunk dramatically. I was, to say the least, excited.”

RICHARD Nuccitelli
THE ENVIRONMENT
AS AN IMPORTANT PUBLIC POLICY ISSUE

BY GLEN SUSSMAN

It is not until the well runs dry that we know the worth of water.

— BENJAMIN FRANKLIN
During his last year in office, President John F. Kennedy embarked on a five-day journey across the United States to talk about the conservation of natural resources. In a speech at the University of North Dakota on Sept. 25, 1963, he stated: “So we come on this trip to remind the American people of what they have, and to remind the people of what they must do to maintain it.” Kennedy’s message was prescient since it reflected the emerging “paradigm shift” between two competing worldviews – namely, the Dominant Social Paradigm (DSP) and the New Environmental Paradigm (NEP). The DSP reflects the view of the industrial era where economic and population growth and continued exploitation of natural resources can continue without damage to the environment. The NEP that emerged in the mid-to-late 20th century challenged this perspective and offered instead the view that more emphasis must be placed on environmental protection and the development of a systematic way to address the increasing depletion of natural resources.

In short, where the DSP emphasized development and production; the NEP has promoted conservation and sustainable development. Moreover, along with this paradigm shift have come changes in the character and diversity of environmental problems. The environment is an important public policy concern has evolved over the years from public land issues to more complex and controversial issues including foreign and defense policy. Where the DSP emphasized development and production, the NEP has promoted conservation and sustainable development. Moreover, along with this paradigm shift have come changes in the character and diversity of environmental problems. The environment is an important public policy concern has evolved over the years from public land issues to more complex and controversial matters.

The environment became a legitimate policy issue in American politics during the 1960s and 1970s. As it emerged on the public agenda, the environment became subject to the actions of politicians and others within the American political system. The American president, Congress, interest groups, citizens and each state all play a role in shaping environmental policy. For instance, where some presidents have pushed conservation, others have promoted a pro-development approach that reduces regulations on business and industry. Members of Congress exhibited bipartisanship during the 1960s and 1970s in addressing environmental problems. Since the 1990s, however, partisanship has sharply divided Congressional Democrats and Republicans over environmental initiatives. Moreover, organized interests have been very active in the halls of government.

The environmental movement is represented by a variety of groups that differ in size, tactics and strategies. Business and industry has substantial resources to support its attempts to shape environmental policy. Property rights groups that maintain a strong anti-federal government orientation prefer that state and local governments make environmental policy. American citizens have demanded clean air and clean water, and public opinion polls indicate that Americans are generally “green.” However, other issues have superseded the environment, including the economy, jobs, and foreign and defense policy.

Finally, our federal system of government has influenced environmental policy. Prior to the Nixon administration, with a few exceptions, environmental policy was addressed primarily at the state and local level. Over the last three decades, the federal government has become integrally involved in the environmental domain, although implementation of policy is still the primary responsibility of the states. Moreover, when state officials believe that the federal government is not doing enough, the states have stepped forward as “laboratories of democracy” and instituted new policies to address environmental problems, as several have done regarding global warming.

Science and Politics

The science and politics “problem” is also an integral part of the environmental policy process. On the one hand, scientists collect data, employ the scientific method and replicate their studies. Politicians, on the other hand, are guided by factors including electoral considerations, pressure from interest groups and uncertainty. Where scientists are guided by objectivity, politicians may view environmental issues through the prism of ideology or partisanship. Where scientists may need more time to experiment, politicians might need an answer prior to the next election. In short, science might be integrated effectively into public policy or it might be ignored or politicized to meet the needs of those in public office.

Let us use the presidency and global warming as an example. Global warming was known to scientists as early as the late 19th century when Svante Arrhenius, a Swedish chemist, noted that an increase in carbon dioxide in the atmosphere due to industrialization would have a warming effect on global climate. By the late 1950s, on the basis of their research, scientists at Scripps Institution of Oceanography suggested that “mankind is now engaged in a great experiment.” Thirty years later, scientists at the National Center for Atmospheric Research argued that global warming “could well cause climate change over the next two generations as large or larger than civilization has experienced.” These concerns have been supported more recently by the Intergovernmental Panel on Climate Change, a group of the world’s scientists sponsored by the United Nations.

Yet public officials at the highest level of the U.S. government have been divided in their approach to the
issue. In 1992, President George H.W. Bush attended the Rio Earth Summit and supported the Global Climate Change Convention only after it had been revised to reflect voluntary rather than mandatory efforts to reduce greenhouse gases. His position reflected what he considered to be “uncertainty” among the scientific community, possible harmful effects on the economy and political pressure from business and industry.

Five years later, in 1997, President Bill Clinton signed the Kyoto Protocol, which called for mandatory guidelines and timetables in an effort to reduce greenhouse gases. Nonetheless, the treaty was never submitted to the U.S. Senate for ratification because Clinton knew that the Senate would not endorse it. In March 2001, in one of his first actions as president, George W. Bush questioned the science and renounced the Kyoto Protocol, stating that it would be harmful to the U.S. economy and that developing countries, especially China and India, were not bound by the agreement. By 2005, a sufficient number of countries (including the European Union, Japan and Russia) had ratified the Kyoto Protocol, thus putting it into effect. However, without the participation of the United States, which releases 25 percent of the harmful greenhouse gases into the atmosphere, progress on this issue will be less than hoped for.

Environmental Progress

Over the last three decades, a considerable amount of progress has been made in the environmental domain. The 1969 National Environmental Policy Act set the foundation for federal involvement in environmental policy. President Nixon proclaimed the 1970s as the decade of the environment, the Environmental Protection Agency was established in 1970 and more environmental legislation than before—or since—was passed over the next few years. From the 1970 Clean Air and 1972 Clean Water acts to the 1973 Endangered Species Act to the 1974 Safe Drinking Water Act to the 1980 Superfund Act, great strides were made in improving the quality of the environment.

Years later, Jimmy Carter and Bill Clinton created a public land legacy to rival that of Theodore Roosevelt, and George H.W. Bush ensured the passage of the Clean Air Act of 1990. Although Ronald Reagan promoted development over conservation, he was persuaded to sign the Montreal Protocol, which addressed stratospheric ozone depletion (the hole in the ozone layer). George W. Bush has also promoted a pro-development approach to environmental policy and has been criticized by environmentalists, Democrats and the group Republicans for the Environment.

The Global Environment

While much attention is directed to environmental policies within the United States, we also must recognize that we live in an interconnected world and the environment, like many other issues, is transnational in character. Pollutants, carried by air and water, do not recognize national borders. There are several issues—population, biodiversity, loss of habitat, decrease in freshwater supplies, energy sources and global climate change—that should command our attention, issues that require global leadership by the United States. While the latter part of the 20th century was the setting for numerous successes in environmental policy, both at home and abroad, much remains to be achieved. As we move forward in the 21st century, one wonders when “environmental security” will assume its proper place in global politics alongside national and economic security.

Looking Ahead

Several years ago, astrophysicist Carl Sagan focused our attention on domestic and global environmental issues when he stated, “In our ignorance, we continue to push and pull, to pollute the atmosphere and blighten the land, oblivious of the fact that the long-term consequences are largely unknown. . . . The Earth is a tiny and fragile world. It needs to be cherished.” And we might do well to recall the words of Winston Churchill, who once lamented that “there is little glory in an empire which can rule the waves and be unable to flush its sewers.”
HELPING VICTIMS OF SEXUAL ABUSE

by Lisa Suhay

Surveys indicate more needs to be done in Virginia’s Emergency Rooms and Private Practices.
HAVING control over your life wrenched away through an act of sexual violence is so transformative, victims suffer its effects long after the initial assault. Just knowing these long-term effects on victims has propelled Stacey Plichta through her career as a researcher. Recently, she was a key member of a team whose study will help improve the way Virginia emergency departments and private doctors assist victims of sexual abuse.

“Such kinds of research is important because healthcare providers need to be trained and have the resources to evaluate, assist and document incidents of sexual assault,” said Plichta, who has been a member of the College of Health Sciences faculty at Old Dominion University since 2001. An associate professor of community and environmental health, she was recently named graduate program director.

Thumbing through a copy of the report she helped generate, Plichta added, “Long term, this kind of study helps patients who have suffered sexual abuse, which is often the underlying cause of disorders such as depression, chronic fatigue and sexual dysfunction.”

A MANDATE FROM THE GENERAL ASSEMBLY

Fundied by the Virginia Department of Health (VDH), the study was conducted by a team of researchers that included five faculty members from Old Dominion. Its genesis was the Virginia General Assembly’s adoption in 2004 of Senate Joint Resolution 131, requiring that the health department study the statewide response to sexual assault victims and the prevention of sexual assault. The mandate was to examine the responses, prevention programs and activities of law enforcement agencies, sexual assault crisis centers and other advocacy and support services, medical personnel and the judicial system and to develop a plan with recommendations for improvement. The VDH contacted the university for assistance in conducting surveys of emergency departments and community-based medical practices as a significant piece of the overall study.

“Thats pretty progressive of them,” Plichta said. “I was very impressed with the legislature on this decision. I was, if anything, surprised to learn there were SANE (Sexual Assault Nurse Examiner) nurses available at so many hospitals, because they dont contribute to a hospital’s profit margin. We are in a time of bottom-line thinking, so this was a good surprise.” Not all of her team’s findings, however, were of a positive nature.

Prior to their surveys, little information was available about the extent to which emergency departments (EDs) are prepared to provide care for victims of sexual violence. Plichta’s research team contacted all 82 publicly accessible EDs in Virginia to examine the structural and process factors that are in place to assist victims.

Her team included the following faculty from the university’s Center for Family Violence Education and Research: Brian Payne, Tancy Vandecar-Burdin, Randy Gainey and Diane Carmody. Also in the group were Yan Zhang, a former student of Plichta’s who is now a faculty member with the Division of Health Services Research, Department of Family and Community Medicine, at Texas Tech University; Rebecca Odor, director of sexual and domestic violence prevention with the Virginia Department of Health’s Center for Injury and Violence Prevention; Addie Magnant, the wife of a former ODU doctoral student, who served as a research assistant; and Shani Reams, sexual violence services coordinator with the Virginia Sexual and Domestic Violence Action Alliance.

In order to collect the necessary data, Plichta had to think not only outside the box, but also beyond the realm and timetable of conventional phone surveys. Magnant was enlisted due to her status as a new mother. “We needed someone to make calls from midnight to about 4 a.m. because that is when emergency room directors and head nurses tend to end their shifts. Addie had a new baby, so I knew she was up at those hours,” Plichta explained.

The surveys led to some interesting conclusions. “I wasnt surprised when we found that, in general, Virginia’s EDs are providing needed medical services to victims,” said Plichta. “However, less than half are consistently doing so with specially trained personnel like forensic nurses. The majority are not training their medical staff specifically for dealing with victims of sexual violence.”

INADEQUATE RESOURCES AND TRAINING

According to the Plichta team study, at least half of Virginia’s emergency departments “do not have the needed resources in place to effectively assist victims and most (80 percent) do not provide regular training to their medical staff about sexual violence. Further, almost one-quarter do not have a relationship with a local rape crisis center.” What’s missing, the study notes, is a full level of services victims need, which would include counseling, evidence collection by a trained nurse and links to other services that offer care for victims.

The team also found that the EDs do not consistently screen their patients for violence victimization (particularly men) and thus may be missing an opportunity to assist some victims.

While the response rate was high for the EDs (75 percent), Plichta said she was shocked by the overwhelming lack of response from directors of community-based medical practices. “Most didnt bother returning our surveys and when we followed up by phone they said, Our patients dont get raped!” What? Its just not even on their radar. Thats incredible to me.”

The study also notes that Virginia’s emergency departments and doctors in private practice see only a fraction of the victims, many of whom choose not to seek medical help or file a report with local law enforcement agencies. The Virginia State Police Uniform Crime Statistics report for 2004 lists
5,187 victims (women and men) of reported incidents of violent sexual/forcible sexual assault. However, Plichta cites a 2003 VDH study that estimated the chances of becoming victims of sexual violence over one’s lifetime (among Virginia residents) were 27.6 percent for women and 12.9 percent for men. Applying these figures to U.S. Census data for adult Virginians, Plichta estimates that 26,000 women and 2,580 men were victims of sexual violence in 2003. These numbers are in keeping with many other studies, which have documented that sexual violence victimization is underreported nationwide, she added.

NEED FOR FURTHER STUDY

“The care-seeking rate for Virginia is low, and the reasons why so few victims seek medical care are worth exploring,” said Plichta. “One possibility is that the services may not be well prepared to assist victims.”

Payne, who serves as chair of ODU’s sociology and criminal justice department and the director of the university’s Center for Family Violence Education and Research, said he was “surprised and disappointed at some of the data that came up as a result of this study. Seeing that so many emergency facilities lack the rudimentary contacts and support systems necessary for helping the victims of abuse was disheartening. Obviously, more attention is needed in this area, including further study.”

Plichta agrees. “This is a subject that needs more of our focus and attention,” she said. “Fifty percent of all women will experience some form of violence in their life and 20 to 25 percent will be raped or sexually assaulted. Also, 30 to 50 percent will be physically or sexually assaulted by an intimate partner, while 18 to 20 percent will be abused sexually as children.”

She concluded, “Having those kinds of numbers in your head and seeing the faces of the victims will keep you going as a researcher, trying to find every way possible to help give them the tools and support to get their lives back.”

A CHANGE IN ACADEMIC FOCUS

Plichta’s interest in researching rape and domestic violence began when she was in college. Her roommate’s experiences as a rape counselor prompted her to shift her academic focus from engineering to pursue a bachelor’s degree in psychology and environmental design at the State University of New York at Buffalo.

“She was working in hell,” Plichta said of her roommate. “We talked a lot about what she was encountering. I could not imagine any greater horror than to go through, not only the abuse, but the aftermath and extensive long-term effects. I could not imagine anything worse than having control taken away like that. I changed my entire direction in life.” Plichta went on to obtain a doctorate in health services research at Johns Hopkins University.

Through her research and writing, Plichta has achieved a national and international reputation in the areas of domestic and sexual violence. She has presented more than 100 refereed papers at national and international conferences (many of these with students) and has been an invited speaker at numerous national and international symposia. Her journal articles, abstracts and technical reports are cited in more than 650 publications (almost all peer-reviewed), many of which have a direct impact on policy and service.

Some of her work on family violence is cited in clinical guidelines from the U.S. Preventive Task Force, clinical guidelines from the psychiatry profession and policy statements from the American Academy of Pediatrics. Plichta was part of a select group of family violence researchers that responded to the most recent U.S. Preventive Task Force Guidelines for screening for domestic violence (through the Family Violence Prevention Fund). More generally, her work is cited in articles appearing in first-tier journals such as JAMA, the American Journal of Public Health, and Medical Care.

Her work has also been cited in many international sources, such as World Health Organization publications, the British Medical Journal, the European Journal of Cancer, the Annales de Pediatrei (France) and Gac Sanit (public health journal of Spain).
Troubling reports about the ethics and professional conduct of university presidents, faculty members in fields as diverse as history and the sciences and biomedical researchers have been sharing space in news columns recently with accounts of the greedy misdeeds of business and political leaders. The scrutiny has begun to reveal such gross misconduct as plagiarism and the falsification and fabrication of data in the hallowed halls of academe and research laboratories. Indeed, the Department of Health and Human Services reported in July that allegations of misconduct by scientific researchers in the United States hit an all-time high in 2004.

In a survey reported in the journal Nature last summer, less than 1.5 percent of the 3,247 American scientists who responded admitted to falsifying data or plagiarizing other researchers’ work, although about a third did confess to committing at least one of 10 relatively serious acts of professional misbehavior. What seems to be happening is that researchers today are less likely than in the past to describe ethical and professional misconduct as “serious,” the authors of the study suggested. In part, that is a response to the intense competition and demands they increasingly face.

The financial cost of gross misconduct in the biomedical fields has been estimated to be as high as $1 million per case, according to Nicholas H. Steneck, a professor at the University of Michigan at Ann Arbor and a consultant for the federal Office of Research Integrity. In a recent case of fraud, Eric T. Poehlman, a former obesity researcher at the University of Vermont, used data he had fabricated to help him win almost $3 million in government financing.

Problems with responsible and professional conduct are not limited to biomedical research. In a recent survey of students...
and association members by the American Physical Society, 10 percent of the department chairmen who responded reported ethical violations involving students or faculty members in their departments in the last 10 years. Lapses included plagiarism, data falsification, attributing credit to inappropriate authors on publications, and failing to name appropriate ones. When junior members (those receiving their Ph.D. within the previous three years) were surveyed, the picture looked even bleaker: Of those who responded, 39 percent said that, as graduate students or postdoctoral fellows, they had observed or had personal knowledge of ethical violations.

Junior members also reported that, when they were graduate students, they had experienced pressure from their supervisors “to overlook data that did not conform to expectations,” and were treated as technicians rather than active research collaborators. Many of their comments described abuse and unethical treatment by advisers. As a result, the American Physical Society has broadened its ethics statements to include the treatment of students and subordinates.

Are such reports cause for alarm? Do they indicate a significant erosion of professional standards and ethics? Federal regulations require institutions like medical schools, research centers and universities to establish policies and procedures for reviewing, investigating and reporting allegations of scientific misconduct. In addition, professional associations play a key role in articulating ethical standards in many fields and sometimes in enforcing them. But relying on after-the-fact regulatory oversight and the promulgation of guidelines is not enough. We need to know how well — or whether — the members of our profession understand the standards. And for that, our graduate schools need to become more involved than they have been.
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Students report training lapses

Perceptions differed between faculty and students with respect to the training provided in several RCR topics. For example, only 9.8 percent of the faculty indicated that they were not providing students with training on mentor/trainee relationships, whereas 27 percent of the students indicated that they were not receiving such training. Approximately twice as many students as faculty contended that training was not provided in the areas of data management and ownership, publication practices and research misconduct (falsification, fabrication and plagiarism). These results are consistent with the findings from the only other surveys known to the author to have assessed current attitudes and practices at research universities.

It is clear to the Council of Graduate Schools and to many of the faculty, graduate deans and administrators of several universities, that a more extensive assessment of current practices and programs in ethics, professional standards and responsible conduct of research is needed. The survey developed and used at ODU is under consideration for adoption as a national instrument and for National Science Foundation funding. My goal is to establish a national database, possibly at ODU, by which institutions can analyze their own survey data and compare their results to an aggregated "national" set of data and to peer or peer-aspiration institutions.

Our project has also gathered data to suggest important effects of culture and gender in self-assessed knowledge and decision-making skills in areas of RCR, ethics and professional standards. To date we have gathered data on 35 students who attended the RCR workshop held in spring 2005. Analysis of before and after workshop responses suggest that there are important gender and cultural differences in self-assessed knowledge and decision-making skills in the sciences: "I'm a graduate student in education. I don't see a need for RCR training in my field"; "great for science, not necessarily applicable to social sciences"; "I believe that the issue of responsible research applies differently to different departments — it would be unfortunate for arts majors to be required to sit through discussion of the moral and ethical questions contained in responsible human and animal research and the like that applies only to the sciences."

"I believe that the issue of responsible research applies to all of science, not necessarily applicable to social sciences"; "I see a need for RCR training in my field"; "great for education"; "I'm a graduate student in education. I don't see a need for RCR training in my field"; "great for science, not necessarily applicable to social sciences"; "I believe that the issue of responsible research applies differently to different departments — it would be unfortunate for arts majors to be required to sit through discussion of the moral and ethical questions contained in responsible human and animal research and the like that applies only to the sciences."

Continued on page 22

A decade ago, Mark S. Frankel, of the American Association for the Advancement of Science, explained in testimony before the congressionally mandated Commission on Research Integrity that the ethical codes of professional societies fall into three types: aspirational, educational and regulatory guidelines. Aspirational guidelines often lack sufficient specificity, Frankel noted, and many professional societies are reluctant to adopt and enforce regulatory guidelines because regulation is expensive, opens the group to litigation and is distasteful to many academics who don't want to judge their colleagues.

Therefore Frankel agreed with Stephanie Bird, of the Massachusetts Institute of Technology, who urged professional associations to adopt educational guidelines that used the following criteria to assess their effectiveness: Do students and faculty members know that they exist? Do they know how to get them? Do they know what is in them?

Surprisingly, very little information is available to answer those questions. That is why, with money from the Council of Graduate Schools and the Office of Research Integrity, 10 pilot projects at universities, including my own, are working to establish "best practices" for educating students and faculty members in professional standards, ethics and the skills necessary to identify and make decisions about such issues as conflicts of interest, authorship, ownership and use of data, plagiarism and mentor relationships and responsibilities.

We have discovered that one of the areas we know least about — in all fields — is how we convey ethical standards to the graduate students who are entering our professions. Indeed, very few national studies have addressed that, although some campus surveys provide indications. A study conducted from 2001-03 at Western Michigan University found that 71 percent of full-time faculty members and department heads (from arts and sciences, business, engineering, fine arts, and health and human services) indicated that they had regularly or sometimes discussed research ethics with students. By contrast, however, only 39 percent of the graduate students indicated that. When asked if their department provided informal or other training in research ethics, nearly 80 percent said no.

A similar study conducted at the University of Nebraska at Lincoln in 2004 also found that, generally, faculty members believed that they and their departments played more of a role in providing training and advice on professional standards and ethics than the graduate students reported. Those findings are consistent with the American Physical Society's 2004 report, which concluded, "It appears..."
that norms of professional conduct assumed to be familiar and practiced by all are, in fact, not universally understood.”

At Old Dominion University, we are examining how factors like gender, ethnicity, culture and discipline affect knowledge and perceptions of ethical and scholarly standards. Our early findings suggest, for example, that male and female graduate students in various fields differ in their understanding of professional standards and ethics. When a group of a nearly equal number of men and women was asked if ethical decisions are made easily and generally agreed upon by most people, nearly 18 percent of the women and less than 10 percent of the men agreed. After attending a workshop on ethics, however, the percentage of women answering yes declined to 10.5 percent, whereas the percentage of men increased to 21.2 percent. Such findings may indicate that men and women are affected differently by training programs on ethics, although the implications require further study.

Other evidence suggests that students of different cultural backgrounds hold dissimilar definitions of misconduct and professional behavior. For example, an article in The Chronicle a few years ago reported that plagiarism is prevalent in China because the culture has had little concept of intellectual property. Other nations stress copying as a way of learning. Those observations raise important questions regarding the content and the expected outcomes of programs intended to raise awareness of ethical and professional standards. As higher education becomes more international, as more women enter graduate study and as scholarship becomes increasingly interdisciplinary, training programs must address the issues of culture, gender and discipline.

As the 10 pilot projects financed by the Council of Graduate Schools and the Office of Research Integrity approach completion in the next few months, a number of points are becoming clear. To successfully increase the level and effectiveness of graduate school training in ethics and professional standards, faculty involvement is crucial — and it will require solid data to demonstrate to faculty members that their commitment is needed. To provide such data, the council, the Office of Research Integrity and the 10 pilot projects are working toward the establishment of instruments to test students’ knowledge of
nine core RCR areas. For example, when asked to evaluate the validity of the statement: “There are well-established standards on the ownership and use of data,” more than 49 percent of the women but none of the men responded that they were “unsure.” To the statement “Ethical decisions are made easily and are generally agreed upon by most individuals,” 29 percent of the international students but none of the domestic students were “unsure.”

**Ethical thinking often differs**

Further analyses suggest that gender and culture also influence the effects of the workshop on participants’ knowledge and skills. Prior to the workshop, a similar percentage of males (14.3) and females (11.8) indicated they were “unsure” about the statement “A mentor’s needs take precedence over his/her students’ needs.” After the workshop, however, the percentage of males indicating they were unsure declined slightly to 12.5, whereas the percentage of women increased over twofold to 26.3. When asked to evaluate the same statement, 13 percent of domestic and 14 percent of international students were unsure. After the workshop, the percentage of domestic students answering unsure increased to 27 percent but among the international students the unsure response rate fell to 8 percent.

These and other findings from this study need further examination to determine their validity and to explore the underlying causes of these suggested differences among gender and culture. In addition, discipline effects were not tested because of the small numbers of non-science students relative to students in science programs who have taken part in this project.

We are currently working to refine this questionnaire and hope to develop a two-tiered training program. One tier would be a program that would provide training and annual assessment of knowledge and skills in areas common to all disciplines, e.g., ethics, conflict of interest, mentor/mentee relationships, data management and publication. Self-paced and Web-based tutorials, videos and links to additional general and discipline-specific information and practices would be developed. Follow-up seminars and group discussions of case studies with topic experts would allow students and faculty to deepen their understanding and exercise their skills. The second tier would be based in each of the colleges and their disciplines.

**Acknowledgements:** The ODU project cited in this article was conducted by the following members of the ODU RCR Task Force: Susan Metosky, former research compliance officer, Office of Research; Lisa Eckenwiler, associate professor of philosophy; Laurel Garzon, associate professor of nursing; Cynthia Jones, professor of ocean, earth and atmospheric sciences; Zhongtang Ren, doctoral graduate student in urban studies; Anusorn Singhapakdi, professor of marketing; Resit Unal, professor of engineering management; and Barbara Winstead, professor of psychology. The author also wishes to acknowledge Sylvia Papachristoforo, a graduate assistant, and Suzanne Finnerty, an administrative assistant, who contributed significantly to the administration, management and analysis of the survey and questionnaire responses.
Philip Langlais (in coat and tie) is flanked by other members of the ODU Ethics and Responsible Conduct of Research Task Force: Resit Unal, Laurel Garzon, Cynthia Jones (seated), Barbara Winstead and Zhongtang Ren, doctoral student in urban studies. Not present for the photo were task force members Lisa Eckenwiler, Anusorn Singhapakdi and Susan Metosky.
A Nuclear Family

World-class nuclear physics research group probes matter at its fundamental level

BY JIM RAPER
They are an earnest group of nuclear physicists who wrestle with dense theories and do experiments with a speed-of-light electron accelerator in order to investigate the fundamental nature of matter.

They also are an amiable and close-knit klatch of Old Dominion University faculty members—11 men and one woman—who are not at all reluctant to step outside the stereotype of single-minded scientist.

One member of the group revels in his striking resemblance to Albert Einstein. Another brings physics alive by dropping pumpkins from tall buildings and teaching a course titled “The Physics of Music and Music Reproduction.” Still another applies his physics training to the investigation of haunted houses. And a fourth is apt to present an impromptu lecture about the wine he imports unofficially from his family’s vineyard in Italy.

Group members are known on campus and in the Hampton Roads region for their genial personalities and their outreach efforts to explain what scientists do.

ANATOLY RADYUSHKIN, eminent professor of physics; APS Fellow
Doctorate: Moscow University
Research focus: As a theorist, he has helped to create generalized parton distributions (GPDs), a set of mathematical functions describing quark position and movement inside nucleons. GPDs have allowed physicists to obtain 3-dimensional “snapshot” of the inner structure of nucleons.
JOZEF DUDEK, assistant professor of physics
Doctorate: University of Oxford, England
Research focus: He joined the ODU faculty in summer 2006 after working as a researcher at Jefferson Lab. His theoretical work involves models of hybrid mesons (certain combinations of quarks) expected to be produced in an experiment that will be made possible by the power upgrade at the lab. He also is working with computer calculations of the theory of strong interactions (QCD) and with new techniques of partial wave analysis vital to successful interpretation of experimental spectroscopic results.

J. WALLACE VAN ORDEN, eminent professor of physics; APS Fellow
Doctorate: Stanford University
Research focus: A theorist of international repute, he has formulated theories that are the basis for many of the experiments at the Jefferson Lab. Present understanding of nuclei with two and three nucleons is largely dependent on his work.

ROCCO SCHIAVILLA, eminent professor of physics; APS Fellow
Doctorate: University of Illinois, following study at the University of Pisa, Italy
Research focus: A theorist, he is a prolific scholar whose publications have been cited more than 2,300 times by other scholars, reflecting his groundbreaking contributions. His model of the interaction between two nucleons is so widely adopted, it has come to be known as the “standard nuclear model.”

IAN BALITSKY, professor of physics
Doctorate: St. Petersburg Nuclear Physics Institute, Russia
Research focus: A theorist, he has focused his research on the theory of quantum chromodynamics (QCD) addressing the core structure of nucleons. He has special interests in high density QCD and deeply virtual compton scattering.

“Old Dominion physicists, in collaboration with scientists at the Jefferson accelerator laboratory, are unlocking the secrets of atomic and nuclear structure.”
—PROVOST THOMAS ISENHOUR
The group has international flavor

Russia, Kyrgyzstan, Armenia, England, Italy and Germany are home countries for seven of the group’s members, but this presents no obstacles to collaboration, Dodge says. “We in nuclear physics take for granted that we routinely work with many people from other countries. Honestly, I am rarely aware of the international flavor of the group.”

Seven of the group, including Dodge and Weinstein, are in experimental physics, while five are theorists. Charles Hyde-Wright, an experimentalist, says nuclear physicists from both sides of the aisle cooperate unusually well at ODU. “We enjoy a close interaction between theorists and experimentalists in the group. It is surprising, but true, that this is rare in our community.”

Anatoly Radyushkin, a nuclear theorist in the former Soviet Union who came to ODU in 1992, has profited from an informal collaboration with the experimentalist Hyde-Wright. Radyushkin is known throughout the nuclear physics world for his role in developing a mathematical model—called the generalized parton distributions (GPDs)—of how particles are distributed and move inside the nucleons that make up the nucleus. He credits Hyde-Wright, a pioneering designer of the nucleon probe technique called virtual compton scattering, with offering insights related to compton scattering that helped to bring about the GPD theory.

Old Dominion has made a commitment to rise into the Top 100 of the nation’s public research universities—as determined by research expenditures—and it seems certain that these nuclear scientists will be among the chief architects of the institution’s advancement. The group is one of the largest of its kind at an American university, and the size is evidence of Old Dominion’s commitment to nuclear physics.

The most recent external review of the university’s physics graduate program in 2001 stated, “The department’s efforts to build a strong group in nuclear physics is an unqualified success. The nuclear group is one of the largest and among the best in the country, and enjoys a level of external support that is on par with or slightly above the national average per faculty funding. Prospects for increased funding are excellent. This is a young group on the rise, with lots of potential.”

Relationship with Jefferson Lab is critical

Dodge says that the research group is strong for two key reasons. The first is the scant 20 miles that separates the ODU campus from the site in Newport News of the Thomas Jefferson National Accelerator Facility, one of the world’s premier atom smashers. The second is the university administration’s decision nearly two decades ago to allocate the resources necessary to develop a relationship with the Jefferson Lab. All of the ODU nuclear theorists are also staff scientists at the lab.

“I came to ODU in 1995 because Jefferson Lab was nearby and because of the extremely high caliber of the experimentalists and theorists who had been hired before me,” said Dodge. In fact, all but one of the present nuclear research group have come to ODU since 1992, when Jefferson Lab was starting up.

In 2005 the experimentalists were awarded $1.72 million by the Department of Energy, which administers Jefferson Lab, to continue their investigation of the underlying structure of subatomic particles and the forces that create them. The funding extended an original grant that dates to 1996. This latest award was one of the largest of its type, and ODU’s was the 18th largest among DOE’s most recent 173 nuclear physics awards.

The amount of the grant was a pleasant surprise for the researchers, who had feared that their funding may be eroded by recent cuts in federal spending on basic science. “The size of this very important grant reflects the contributions of our faculty and the importance of the research being done at the Jefferson Lab,” says Richard Gregory, former dean of the College of Sciences and current chair of the chemistry and biochemistry department.

The DOE also funds the work of the theorists by means of grants and contributions to their salaries. Numerous faculty honors and awards have gone to the nuclear physics group recently. Hyde-Wright was...
elected in December as a Fellow in the American Physical Society, becoming the third member of the group to hold the prestigious designation. (All told, the physics faculty has nine members who are APS Fellows.) Hyde-Wright also won the College of Science’s top faculty award for excellence in 2006. Weinstein won the college’s top faculty excellence award in 2005 and the college’s distinguished teaching award in 2006. (Hyde-Wright is the pumpkin-drop sponsor and clarinetist and Weinstein has investigated haunted houses in his role as an officer of the organization Science and Reason in Hampton Roads.)

Rocco Schiavilla, a theorist within the group, won the universitywide faculty research award for 2006 and a few weeks later was elevated to eminent scholar. (He is from the winemaking family in Italy.) Radyushkin was the 2004 Virginia Outstanding Scientist, as chosen by the Office of the Governor and the Science Museum of Virginia.

Nuclear physics provides technology upgrades

The nuclear group explores the nuclei of atoms, and the fruits of the research could help to make science fiction come true during the 21st century. If the basic constituents of matter will give up their secrets and submit to manipulation, the world could see a paradigm upgrade of technologies. The common use today of magnetic resonance imaging (MRI) in medical diagnosis is only one small example of nuclear science in practical application. Ahead lie abundant opportunities for scientists to harness the energies and quantum quirkiness of subatomic particles in order to boost the quality of human life all over planet Earth.

Before that happens, however, scientists need to better understand the underlying structure of subatomic particles and the forces that create the particles. This is the task of the nuclear physics group and it reflects their interest in fundamental science.

“We do not focus on applications of our work. It is the intellectual interest that drives us,” says Dodge. “But it is important to realize that money spent on basic science, which does not have an immediate commercial application, usually yields great dividends to society down the line. We must be content in knowing that we are contributing to knowledge that will benefit everyone eventually.”

Thomas Isenhour, the ODU provost, is a chemist and former dean of the College of Sciences who is very familiar with the relationship between the university and the lab. He also is a history of science scholar, and can deliver an impromptu lecture about the discovery of the atomic nucleus by Ernest Rutherford in 1911. “The nucleus, which makes up only about 1 billionth of the volume of the atom, nonetheless contains 99.9 percent of its mass,” Isenhour explains. “For almost 100 years scientists have designed ever more sophisticated experiments to probe the inner workings of the nucleus and explain the basic building blocks of matter. Old Dominion physicists, in collaboration with scientists at the Jefferson accelerator laboratory, are unlocking the secrets of atomic and nuclear structure.”

The nature of the contributions of ODU nuclear physicists is not for the layman to understand in any detail. The matter that humans think of as tangible is made up of atoms, which are made up of nuclei and their orbiting electrons. Nuclei are made of nucleons (protons or neutrons), which are made of quarks and gluons.

These basic components of matter illustrate Einstein’s accurate prediction that, at the core of matter, mass seems to be interchangeable with energy. In fact, matter hardly fits the description of “tangible” when you break it down. About 98 percent shows up as energy. This leads to some big questions. How in the cataclysmic Big Bang were the nuclei of atoms formed? How can we characterize the “glue” that holds together the basic building blocks of matter? How do these building blocks act outside the nucleus as compared to inside? Why is there tangible stuff at all, and not simply one universal soup of energy?

Accelerator is brightest “microscope”

To answer these questions, and many others, physicists need to “peer” theoretically or virtually at the innards of the nuclei. Eventually, this requires that the physicists break apart the nuclei and nucleons that nature put together. In other words, they need to smash atoms and record what happens. They can do this at Jefferson Lab, the $600 million Department of Energy facility in Newport News. The central instrument is a mile-long, continuous-beam electron accelerator that smashes atoms. Also, there are several large, particle-caching detectors.

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LAURENCE WEINSTEIN, professor of physics
APS Fellow
Doctorate: Massachusetts Institute of Technology
Research focus: In experiments at the Jefferson Lab, he studies how the behavior of pairs of protons and neutrons in the nucleus of the atom is different from the behavior of individual nucleons. Nucleons in pairs are more energetic, and he has related their behavior to human couples, who act differently when together than when alone.
Paul Ulmer, professor of physics
Doctorate: Massachusetts Institute of Technology
Research focus: He uses the high-energy electron beam at Jefferson Lab to knock protons out of nuclei in order to understand the nature of the strong interaction that binds the nucleus. An experiment of his on the helium nucleus will help to reveal whether protons inside a nucleus have the same properties as isolated, or free, protons.

Gail Dodge, professor of physics
Doctorate: Stanford University
Research focus: Her experiments at Jefferson Lab investigate the basic angular momentum—or spin—properties of the nucleon. In particular, she is interested in studying the neutron and its excited states, called resonances. At present, she also is chair of the steering committee that will oversee construction of the CLAS12 detector in conjunction with the planned power upgrade at Jefferson Lab.

Moskov Amarian, associate professor of physics
Doctorate: Yerevan Physics Institute, Armenia
Research focus: As an experimentalist at Jefferson Lab, he has continued work involving exotic particles with pentaquark structure that he began as a research scientist at the DESY research facility in Hamburg, Germany. He also has research interests in spin structure of the nucleon and in Compton scattering.

Sebastian Kuhn, professor of physics
Doctorate: University of Bonn, Germany
Research focus: He investigates the internal structure of nucleons and their interactions. He led experiments at Lawrence Berkeley Lab and the Stanford Linear Accelerator Center in California, as well as at TRIUMF in Vancouver, before his affiliation with the Jefferson Lab.

“[It is important to realize that] money spent on basic science, which does not have an immediate commercial application, usually yields great dividends to society down the line.”

— GAIL DODGE
tors that, with the help of computers, produce post-collision “pictures.”

The atom smasher and a detector work in combination like a huge and very powerful microscope. “We need to probe matter with the best resolution possible, using the most powerful ‘electron microscopes’ available,” says ODU nuclear experimentalist Sebastian Kuhn. “The accelerator at JLab is the brightest such microscope in the world, and that is why scientists from around the world come here to study the origin of mass.”

Jefferson Lab is in the early stage of a $225 million to $300 million upgrade that will—if fully funded—increase the available energy of the facility’s continuous beam of electrons from about 6 billion electron volts to 12 billion. The upgrade would be similar to doubling the strength of the “microscope” that Kuhn described. For example, it would allow new experiments that could extend the significance of Hyde-Wright’s work with virtual compton scattering.

Even without the increased power, there is much interesting work that can be done at the lab. One of the world’s leading authorities on the pentaquark, a five-quark particle whose existence is disputed, is Moskov Amarian, another former Soviet scientist and the most recent experimentalist to join the ODU nuclear group. When the American Physical Society wanted an update on the pentaquark search at its spring meeting in 2005, Amarian was invited to present a talk on the topic. In the spring of 2006, he was knee-deep in new atom-smasher data related to the pentaquark and weighing evidence for or against the particle’s existence.

But any interview with him cannot go on too long before the inevitable question must be asked: When you are out in public, do folks stare at you and think you must be Albert Einstein?

He smiles and says softly in his heavily accented English, “It happens so often, I, too, begin to believe.”
Patrick Hatcher and COSMIC lab are tops in the chemical analysis business

BY JIM RAPER

Few people outside of organic and environmental geochemistry can appreciate Patrick Hatcher’s innovations with off-line tetramethylammonium hydroxide (TMAH) thermochemolysis, which segments large molecules for analysis by gas chromatography and mass spectrometry.

The same could be said about his vanguard use of nuclear magnetic resonance (NMR) spectroscopy to define how certain macromolecules look and behave.

Suffice it to say that during the past 15 years or so, scientists from universities, hospitals, industries and government agencies have lined up to work with him on projects requiring chemical analysis of hard-to-analyze compounds. His research applies to some of our biggest 21st century environmental and health challenges, such as water quality, global warming and the origins of disease.

Since January 2006, Hatcher and his wife and collaborator, Susan, have been putting their skills to work on behalf of Old Dominion University. He is the new Batten Endowed Chair in Physical Sciences and the director of the university’s new College of Sciences Major Instrumentation Cluster (COSMIC@ODU). Susan Hatcher is the day-to-day manager of COSMIC.

Organic molecules—those originating with living organisms, as well as those that are synthesized—are typically very large and complicated in the relative scheme of chemical compounds, and their structures have been difficult to elucidate.
**Instrumentation is second to none**

But Hatcher’s creative analytical strategies have given science a much better understanding of coal, petroleum and natural polymers, of the ways sediment and soil interact with pollutants at the molecular level, and of how natural organic material can thwart the treatment of drinking water. His work also has advanced biochemical studies of proteins and other biological compounds.

COSMIC, which became operational in March, is among the best equipped in the world. The centerpiece of COSMIC’s array of instruments will be a 12-Tesla Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometer that promises to be a monument of sorts to the university’s increased emphasis upon research.

ODU’s 12-Tesla mass spectrometer is only the second of its type to be installed in a university facility in the United States, and the only one devoted to broad analytical use in earth sciences as well as life sciences.

The central component of the $1.3 million mass spectrometer is a 4-ton superconducting magnet nearly 500,000 times stronger than the Earth’s magnetic field. The magnet, together with the other parts of the mass spectrometer, was delivered by two large trucks in February to the COSMIC laboratory in the Oceanography and Physics Building.

The delivery also included a $500,000 400 MHz solid-state nuclear magnetic resonance (NMR) spectrometer with the latest High Resolution Magic Angle Spin (HRMAS) capability. It contains a 9.4-Tesla magnet that is considerably smaller because of its design than the magnet in the FT-ICR mass spectrometer.

**Startup is complicated**

The installation and startup processes for the two instruments required the services of about a dozen experts who are employed by or have been hired by the Bruker Companies, the instrument manufacturer. Perhaps the most complicated of the services was cooling the superconducting magnets—by means of liquid nitrogen and liquid helium—to temperatures approaching absolute zero (about minus 450 degrees Fahrenheit). Because of technical challenges with the custom-built 12-Tesla magnet, Bruker engineers spent nearly a month, or twice as long as they had planned, to bring the mass spectrometer to working order.

A half-dozen ODU employees spent a great deal of their time over three months preparing a laboratory space for the instrument, upgrading electrical and exhaust systems, widening doors for deliveries and handling a mountain of smaller details.

“We are providing state-of-the-art scientific equipment that will allow Dr. Hatcher and others in our colleges of sciences and engineering to perform the most advanced analytical research possible,” says Roseann Runte, president of the university.

“COSMIC@ODU has one of the country’s top researchers as its director and is one of the best equipped facilities of its type in the world. We thank Frank Batten for the gift that enabled us to attract Dr. Hatcher, to create this facility and to take a giant step toward our goal to become a Top 100 public research university.”

Barten, the founder of Norfolk-based Landmark Communications Inc., gave $32 million in 2003 to promote research at ODU, paving the way for the university to plan a facility such as COSMIC and attract a highly qualified scientist to run it.

Explains Thomas Isenhour, the ODU provost and a chemist who is the former dean of the university’s College of Sciences: “Throughout the history of science, those with access to the most sophisticated instrumentation have made the great advances. With the COSMIC facility, ODU is positioned at the cutting edge of several areas of science.”

Hatcher earned a bachelor’s degree in chemistry from North Carolina State University, a master’s in marine chemistry from the University of Miami and, in 1980, a doctorate in chemistry (geochemistry) from the University of Maryland. As a graduate student he began experimenting with new ways to use spectrometry and spectroscopy. He elaborated these experiments into a specialty while he was employed first by the U.S. Geological Survey in Reston, Va., then by Penn State University and Ohio State University. He and his wife, Susan, a mass spectrometry special-
“OUR NEW INSTRUMENTATION CENTER WILL ELEVATE ODU TO A NEW LEVEL IN EARTH SCIENCES, TO A LEVEL HIGHER THAN MOST UNIVERSITIES. IT WILL BE A FEATHER IN THE CAP OF THE ODU OCEAN, EARTH AND ATMOSPHERIC SCIENCES AND CHEMISTRY AND BIOCHEMISTRY DEPARTMENTS.” —PATRICK HATCHER
Hatcher has a joint appointment at ODU to the chemistry and biochemistry department and the ocean, earth and atmospheric sciences department. Certainly one major reason for our coming here was that ODU has seen fit to make available the latest technology."

Hatcher has a joint appointment at ODU to the chemistry and biochemistry department and the ocean, earth and atmospheric sciences department.

**Research reputation gets a boost**

"COSMIC and the arrival of the Hatchers, according to Richard V. Gregory, former dean of the College of Sciences and current chair of the chemistry and biochemistry department, will provide a major boost to ODU's reputation as a research university. "We can attract outstanding faculty candidates as a result. We expect to establish new funded areas of research, to dramatically improve our own research infrastructure and to enhance our collaborations in research with EVMS and other institutions." Gregory credits several members of the ODU faculty with championing Hatcher's candidacy, including Kenneth Mopper, professor of chemistry and biochemistry, and Andrew Gordon, professor of biological sciences.

"ODU, and Hampton Roads in general, will greatly benefit from Dr. Hatcher's arrival," says Mopper. "We are indeed lucky to have recruited such a renowned and highly accomplished scientist. Dr. Hatcher has a long record of catalyzing and leading interdisciplinary teams that have secured large interdisciplinary grants dealing with important environmental issues. In addition, he is well versed in advanced analytical instrumentation and has adapted these techniques for investigating nature and reactivity of complex natural organic matter in terrestrial and marine ecosystems."

Gordon has known Hatcher since the late 1970s when they shared a mentor at the University of Miami. "His thesis work dealt with long-term geological/chemical changes to natural organic compounds and what is happening to them with time requires the type of instrumentation and analytical skills at which Dr. Hatcher excels. I am looking forward to getting reacquainted with his work and to possible collaboration."

COSMIC analysis will be available to ODU researchers and for a fee to academics and other scientists outside Old Dominion University.

Hatcher and his wife were just beginning formal experiments with the new, high-resolution instruments in early spring 2006. "Collaborators and customers are starting to line up," he says.

"Yes," adds Susan Hatcher, "I've already got four customers eager to get started. I have to tell them to be patient."
If it’s Tuesday, this must be Pittsburgh

When Mark Dorrepaal was growing up in Ontario, just across the border from Detroit, he was a devoted fan of the Tigers and, like many boys, was a student of Major League Baseball (MLB) statistics. But, unlike most young fans, Dorrepaal had an interest in statistics that extended well beyond the performance of players. He found fascination in baseball schedules. “The Yankees would come to town, and I’d wonder, where were they last night, where will they travel next, and where are all the teams at any one time,” said the man who now chairs the Old Dominion University Department of Mathematics and Statistics.
Major league baseball could use a scheduling whiz like ODU’s Mark Dorrepaal
This boyhood fascination never left him, and to prove it, Dorrepaal chalked up a remarkable achievement this spring as the major league season was getting under way. He jumped into the lead of a World Wide Web-based contest to develop an optimized schedule for National League teams.

He accomplished his feat without computer genius, which is what drives the sports scheduling of most of his competitors. He did it with paper and pencil and “noggin’ power.”

Even people who do not follow baseball can appreciate the kind of interdependent scheduling that helps airplane travelers make their connections or keeps a school bus driver from traveling wasteful miles or making wasteful stops. Many people, too, have heard of the decades-old mathematical word problems involving a traveling salesman who wants to know the most efficient way to visit several cities on a business trip.

Road trips can be killers

But no schedule seems as complex as the ones for the major league baseball season. Imagine 14 or 16 teams—depending on the league—playing 162 regular season games apiece. Also consider what the experts call the scheduling “constraints.” The Yankees, for example, would rather be playing road games outside of New York when the Mets are playing home games, to minimize competition for spectator dollars. Also, for various reasons, including player fatigue, no road trip by a team should be longer than, say, 11 days.

Efficiency hinges largely on miles traveled, so the Mets would not want a road series that took them first to San Diego, next to Atlanta and then back to the West Coast to play San Francisco. The more efficient itinerary would take the Mets to San Diego, Los Angeles and San Francisco.

Only recently have the major leagues begun to rely on sophisticated computing in order to fashion efficient schedules. Because there are billions of possible schedules, however, the National League (NL) and American League (AL) remain far from certain about how close they are to optimal travel schemes. In other words, they know that they could be traveling many unnecessary miles each season.

About seven years ago, an academician under contract to MLB instituted the Challenge Traveling Tournament Web site (http://mat.gsia.cmu.edu/TOURN/) to solicit efficient schedules for baseball and other sports from hobbyists such as Dorrepaal and anyone else who was willing to participate just for the honor of getting a citation on the Web. The site’s originator and keeper is Michael Trick, professor of operations research at Carnegie Mellon’s Tepper School of Business.

Several separate baseball scheduling contests are on the Web site, all for National League (NL) teams. For instance, you can try scheduling a season for only six NL teams, or eight, and so forth, just to get the hang of it. The contest that Dorrepaal led in the spring of 2006 is the 14 NL team schedule. (The NL has 16 teams.)

A hobby for three decades

Competitors are given distances for travel between the NL cities, and directed to make a schedule in which each team plays each other both home and away. The schedule is subject to constraints, such as no more than three consecutive home stands or road stands, as well as no consecutive home/away stands between the same teams. The objective is to complete the schedule with the fewest miles of travel for all teams.

In the 1970s when he was in graduate school at the University of Toronto, Dorrepaal mailed off his first schedule to MLB. He served up another one in the late 1980s after he lost his wife to cancer and found himself working on the scheduling problem as a diversion. He never got more than a thank-you letter for all his effort.

Having his name on the Web site now as leader of the 14 NL team contest is a far greater reward, he says. How did he surge into the lead? Since 2002 he has been a top-drawer performer on the scheduling Web site, but several computer experts, including Pascal Van Hentenryck, professor of computer science at Brown University, blew onto the site a few years ago with the kind of sophisticated software that can run circles around a paper and pencil guy such as Dorrepaal.

Van Hentenryck, who currently leads the 16 NL team contest, took the lead in the 14 NL team contest in May 2004 with a miles total of 189,766. “The big boys had been trading the lead for a year or so in the 14-team contest, and Van Hentenryck’s new low miles total in the spring of 2004 seemed to be hard to beat,” Dorrepaal said.

But the ODU professor wasn’t ready to admit defeat. Early this year, he began poring over the Van Hentenryck schedule when he had his “eureka!” moment.

“His computer program is quite good. There is no question about that,” Dorrepaal said of Van Hentenryck. “But in doing a good job on the big picture, the program missed a shortcut or two.”
Dorrepaal came up with a schedule that required only 189,759 miles of team travel, seven miles better than Van Hentenryck’s best total.

CAA basketball may benefit

The next quest would be a manual analysis of Van Hentenryck’s 16 NL team schedule. But Dorrepaal is not sure he wants to put himself, and his collaborating graduate student, George Chackman, through the rigors of another analysis.

“Frankly, I’m not the computer genius you need to be,” said Dorrepaal, who has been on the ODU faculty since 1976. “I am maximizing my publicity with a minimum amount of ability.” (Editor’s note: Van Hentenryck retook the lead in the 14 NL team contest from Dorrepaal after this article was written. For the latest result, see the Web site.)

But the Web site competition, and his success, has sparked his interest in developing a scheduling template, or broad scheduling theorems, that might apply to many scheduling problems. He also has been talking with the ODU psychology professor Janis Sanchez-Hucles, the university’s NCAA representative, about advice he might give the Colonial Athletic Association about basketball scheduling.

He hopes that some of the scheduling patterns the Web site competition has produced will be used by MLB. He noticed that the 2006 schedule included some of the optimizing characteristics that are evident in the competition’s best entries.

“I sent a note to Professor Trick asking whether the current major league schedule was generated by a software program similar to the ones used to generate solutions on the Web site,” Dorrepaal explained. “He answered that he and George Nemhauser (professor of industrial and systems engineering at Georgia Tech) had done the 2005 schedule and that the current schedule was done by a Canadian company—a tiny, three-man outfit—that uses optimization software.”

The Canadian company, Optimal Planning Solutions, was founded by a man who at one time scheduled the delivery of frozen french fries to McDonald’s franchises. The company now does scheduling not only for MLB, but also for the National Football League and several hockey leagues.

In the real world, the MLB schedule has constraints, such as those imposed by television or by particular rivalries—between the Red Sox and Yankees, for one—that are not imposed on the Web site hobbyists. “It’s a tremendously complicated choreography,” Dorrepaal said.

He would be the first to admit that computer scheduling experts have supplanted the veteran paper and pencil guys.

But the guys at Optimal Planning Solutions should not be surprised if they get mail sometime over the next few years from a fellow Canadian, a mathematician named Dorrepaal. Inside, they just may find MLB scheduling tips written on a napkin.

Dorrepaal accomplished his Major League Baseball scheduling feat with “noggin’ power,” not with sophisticated computing.
Computer Scientists Will Lead Multi-Institutional Department of Energy Institute

Computer scientists at Old Dominion University lead a multi-institutional team of researchers who have won a $7 million grant from the U.S. Department of Energy (DOE) to develop new software for scientific problem solving on the next generation of high-performance computers.

Alex Pothen, a professor of computer science and a member of the Center for Computational Science at ODU, is the grant’s principal investigator. His collaborators are from ODU, Sandia National Laboratories in New Mexico, Argonne National Laboratory in Illinois, Ohio State University and Colorado State University.

With the funding, the researchers will establish the Combinatorial Scientific Computing and Petascale Simulations (CSCAPES, pronounced “seascapes”) Institute, which will be based on the ODU campus in Norfolk, Va. The institute will support DOE’s broad-based Scientific Discovery through Advanced Computing (SciDAC) initiative.

The CSCAPES Institute will develop software on what the DOE calls its “leadership class” of supercomputers, which are capable of performing trillions of operations per second (teraflops). The goal during the term of the grant is the creation of software for the even more powerful—petascale—computers expected by 2010.

Petascale computers capable of performing thousands of trillions of operations per second—about 100 times faster than current state-of-the-art machines—promise breakthroughs in high-profile research areas such as environmental decontamination, global warming, particle physics, fusion energy, nanotechnology and systems biology.

Hundreds of thousands of processors will make up a petascale machine, and along with the increase in processors will come fundamental new problems for computer scientists, Pothen said. “Anytime you ramp up the performance of computer hardware by factors of 10, the bottlenecks for software change. Things that were not significant before begin to determine the time it takes to solve a problem. If we take our current codes and run them on one of these high-performance computers, we may get only a few percent of the performance the computer can deliver.”

The CSCAPES Institute will tackle this problem by writing new processing recipes in the form of combinatorial algorithms, from which the institute takes its name.

Other ODU researchers on the CSCAPES team are computer scientists Florin Dobrian and Asefaw Gebremedhin.

News of the grant was hailed by ODU administrators as a major milestone in the university’s quest to be a leading research institution.

“Dr. Pothen’s brilliant scientific work coupled with his leadership in organizing a multi-institutional collaboration has resulted in a truly significant grant,” said President Roseann Runte. “We are all tremendously proud of his accomplishments and are looking forward to continued success.”

The DOE made simultaneous announcements on Sept. 7 of four SciDAC institutes dedicated to computer science, applied mathematics and visualization. The other three institutes are at Carnegie Mellon University, the University of Southern California and the University of California, Davis.
Old Dominion University

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