terra

A world of research & creativity at Oregon State University • Winter 2008

The Bridges We Cross

Making Our Travels Safer

LIFELINES

They often don't become apparent until we lose them. And they may be more fragile than we realize. They are the lifelines that connect us to things that matter: roads and bridges that enable goods to get to market; a health insurance plan that provides access to medical care; a scholarship that keeps us in school. We may take them for granted, but it takes care and feeding to make sure they meet modern demands.

Strengthening our lifelines is part of the business of universities. So when inspectors find cracks in highway bridges or when a heavily used span suddenly crashes into a river below, research engineers get busy. In Chris Higgins' bridge lab, he and his student team build full-size concrete beams and then break them to find out how they perform. Their goals are clear: more effective repair techniques, better construction methods and better ways to monitor what we already have in place.

But what happens when lifelines shift? New health-care technologies raise ethical dilemmas that our grandparents could hardly have imagined. For example, the blood of newborn infants has long been a source of information about potential life-threatening conditions. Now, gene-sequencing techniques can reveal details about an infant's life-long predisposition to disease. The question is, How much control should we have over that kind of personal information? How do we balance social responsibility with personal rights? Such questions concern OSU philosopher Courtney Campbell, whose work has ranged across the bioethics landscape from stem cells to Oregon's landmark Death With Dignity Act.

Ultimately, lifelines are personal. OSU's SMILE Program has inspired hundreds of children to study science and attend college. In Oregon, the high school graduation rate is about 75 percent, but for SMILE participants who stay in the program for four years, the chance of getting a high school diploma is more than 90 percent. For more than 20 years, SMILE has been a lifeline to higher education for children from low-income and minority families. One girl told *Terra* writer Lee Sherman simply, "SMILE gives us a better chance."

Terra is another kind of lifeline. Three times a year, we share stories about personal commitment and professional accomplishment. Now we need to know how well the magazine is doing its job. Please take a few minutes to complete the online questionnaire, available at oregonstate.edu/terra. You'll be helping us to strengthen a lifeline between OSU and the people we serve.

— Nick Houtman, Editor

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OSU is Oregon's largest public research university, with $191 million in research expenditures in FY2007. Classified by the Carnegie Foundation for the Advancement of Teaching in its top category (very high research activity), OSU is one of only two American universities to hold the Land-, Sea-, Sun- and Space-Grant designations. OSU comprises 11 academic colleges with strengths in natural resources, earth dynamics and sustainability, life sciences, entrepreneurship and the arts and sciences.

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On the cover
Internationally known bridge designer David B. Steinman incorporated innovative qualities in the St. John's Bridge, which carries U.S. Hwy. 30 across the Columbia River in Portland, Oregon. When it opened in 1931, it was the longest span of its type and the first bridge to use main steel towers without conventional bracing. (Photo: © iStockPhoto.com, Jeff Strickler)

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Also in this issue

On the Web at ***oregonstate.edu/terra***

See beam-breaking action in Chris Higgins' bridge testing lab.

Read the full interview on the politics of safety with OSU political scientist Bill Lunch.

Listen to OSU philosopher Courtney Campbell discuss stem cell research and other issues in biomedical ethics.

See a film clip of Linus Pauling describing his work on "orthomolecular medicine."

Features


616' - 2½"
38' - 9¾"
40' - 0"
40' - 0"
40' - 0"
97' - 0"

Fear and Loading

3' - ½"

6' - ¼"

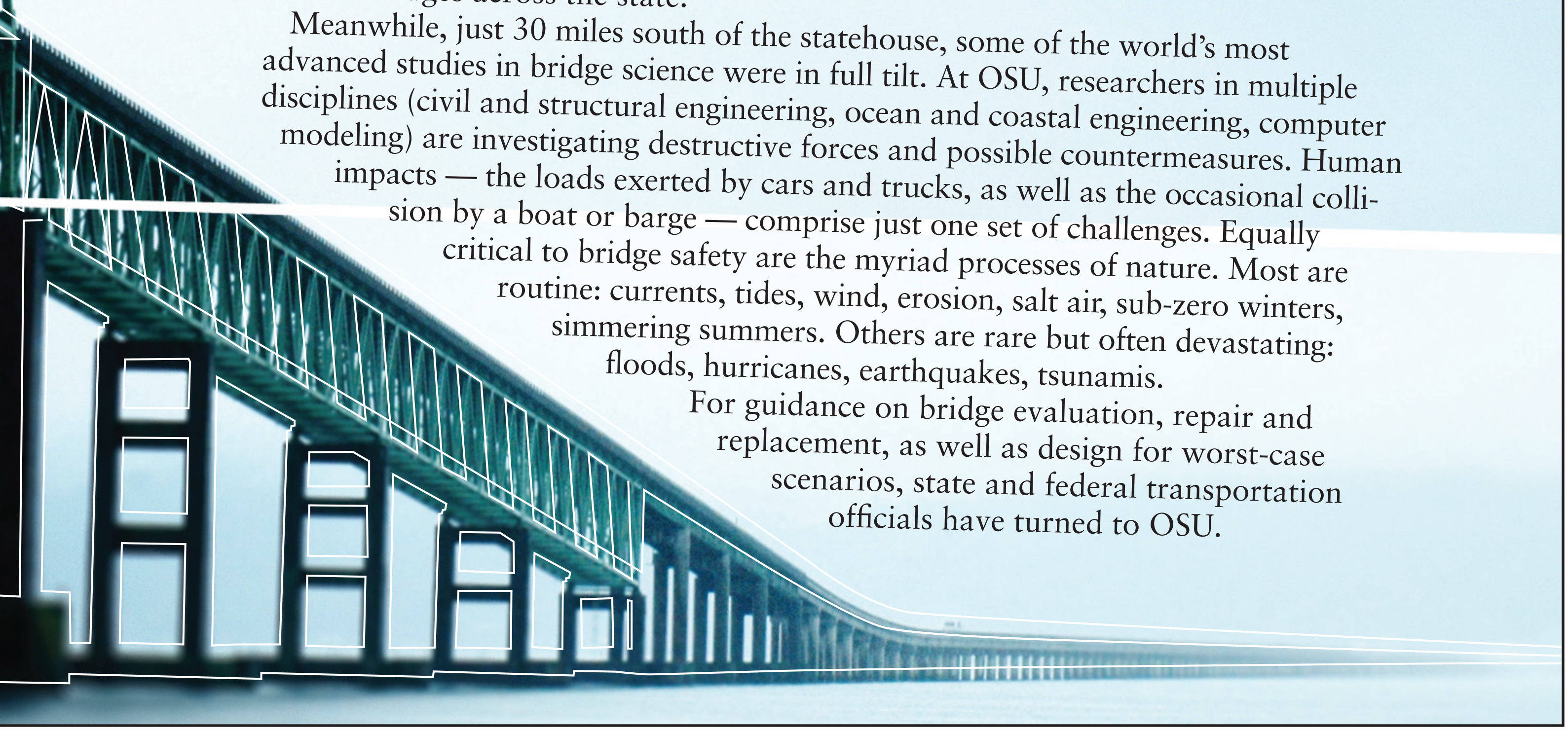
by Lee Sherman

Whether you venture onto a few wooden planks over a trout stream, a steel colossus over a swift river or a concrete viaduct carrying bumper-to-bumper commuters, you trust the beams and girders to hold you up.

This act of faith, made daily by millions of motorists on U.S. highways, was shaken last summer when a steel truss bridge in Minneapolis plunged into the Mississippi River during rush hour. As media coverage raged and pundits called for reform, Oregon Governor Ted Kulongoski ordered an immediate inspection of 34 similar bridges across the state.

Meanwhile, just 30 miles south of the statehouse, some of the world's most advanced studies in bridge science were in full tilt. At OSU, researchers in multiple disciplines (civil and structural engineering, ocean and coastal engineering, computer modeling) are investigating destructive forces and possible countermeasures. Human impacts — the loads exerted by cars and trucks, as well as the occasional collision by a boat or barge — comprise just one set of challenges. Equally critical to bridge safety are the myriad processes of nature. Most are routine: currents, tides, wind, erosion, salt air, sub-zero winters, simmering summers. Others are rare but often devastating: floods, hurricanes, earthquakes, tsunamis.

For guidance on bridge evaluation, repair and replacement, as well as design for worst-case scenarios, state and federal transportation officials have turned to OSU.



Vehicles navigate a maze of concrete and steel ramps connecting to Portland's I-5 Marquam Bridge. More than 135,000 cars per day cross the Willamette River here. (Photo: istockphoto.com, Norman Eder)

High off the ground, a guy in a hardhat sits at the controls of a 35-ton yellow crane. As though born to the task, he pushes and pulls the levers, maneuvering the 100-foot hydraulic boom into position over a 40,000-pound concrete beam. Workers grab the bulky hook dangling from the boom and attach it to the massive slab. They give the thumbs-up. With a deafening roar that makes earplugs standard equipment here, the crane hefts the load and swings it into position.

Construction site? No, engineering lab.

At OSU's Structural Engineering Research Laboratory, experimental precision depends on tools that pound, lift, shake and cut: diesel-powered machines, hydraulic rams, welding torches, rebar benders and shears (trade name, Rodchompers). The guy at the crane's controls, an engineering professor studying the physics of bridges, reveals that his supply lists (which recently included Arctic parkas for his crew of graduate students) have raised a few eyebrows with Research Office accountants.

"I may be the only structural engineering professor in the U.S. who's a certified hydraulic crane operator," says a grinning Christopher Higgins as he climbs down from the cab.

Pointing toward the concrete girder, now encased in a cage of steel columns and rods resembling a giant Erector Set, Higgins projects an almost paternal air. "This guy," he says proudly, "is our Goliath." An intermediate bridge support called a "bent cap," the kind that sits mid-river to support bridges with long spans, carries the integrity of the whole structure. As Higgins explains, "If it fails, you can lose the whole bridge."

As part of Higgins' comprehensive research program on concrete bridge components funded by the Oregon Department of Transportation (ODOT) and the Federal Highway Administration (FHA), Goliath will undergo a series of strength and rehabilitation experiments inside the steel cage, the structural-engineering equivalent of a test tube. The futures of the 155,000 U.S. bridges rated "structurally deficient" or "functionally obsolete" by the FHA could depend on the findings.

Size Matters

To reduce risks of catastrophic collapses on our highways, OSU researchers have taken bridge experiments to a whole new level: life-size. Historically, most studies have been done on miniature replicas. Many models are only a fraction of the size of the real structure, says Higgins, a professor in the School of Civil and Construction Engineering. Trouble is, tests on these scaled-down versions have inherent limitations. A pencil-thin wooden beam, for instance, doesn't act like a two-ton timber, no matter how carefully you design the experiment. That's because the physical properties of wood, concrete and steel differ geometrically with size. So do the forces that impinge on them.

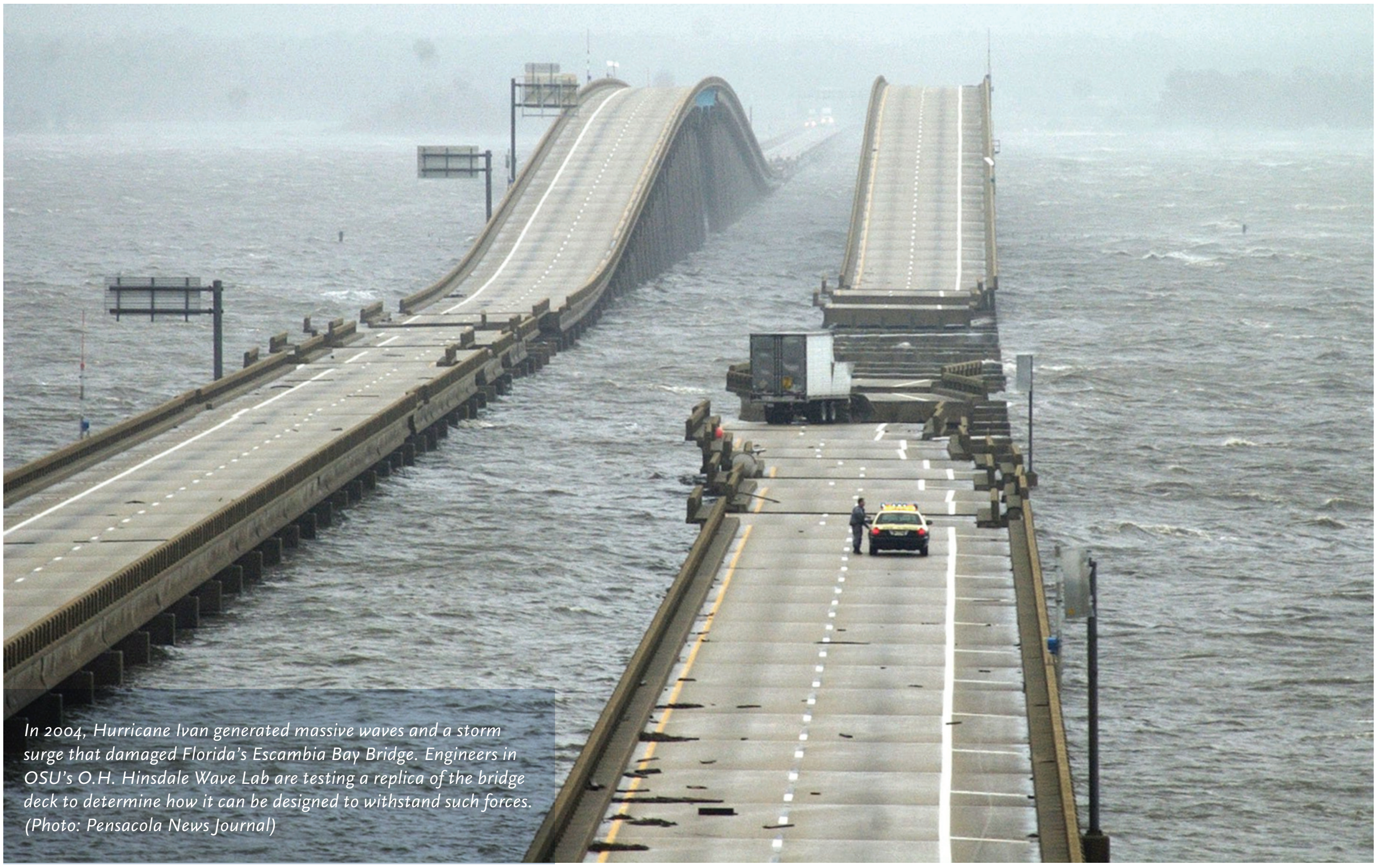
To get around this problem, Higgins tests bridge components that are as big as the ones holding up the phalanx of ramps and overpasses that crisscross every major city in the country. Access to real-size data lets engineers correct the assumptions and interpolations that plague analytical models built on sub-size experiments.

When we think of bridges, behemoths come to mind, like Portland's I-5 Marquam Bridge, which curves dramatically to a knee-weakening summit high above the Willamette River. But the structures Higgins typically deals with are not "the striking or soaring long-span kind that grab people's attention," he says. Rather, Higgins focuses on the mundane and unsung, the "bread and butter" of the highway system, "the ones you cross under and over without even realizing it."

Whether they are aesthetic masterpieces or unlovely chunks of pure functionality, bridges are being asked to withstand the ceaseless crush of ever-bigger, ever-heavier and ever-more-numerous vehicles. So Higgins and his students punish their experimental girders (bent caps like Goliath, along with smaller T-shaped girders called

"We're doing some things that no lab in the world has ever done before. We built a moving load simulator that can actually roll, acting like a truck traveling across full-size girders." — Chris Higgins

Life-size concrete girders are put to the test in OSU's Structural Engineering Research Laboratory, where Professor Christopher Higgins and his crew of graduate students subject the massive bridge components to as much as 1 million pounds of force with hydraulic cylinders that simulate heavy traffic loads. (Photo: Jim Folts)



In 2004, Hurricane Ivan generated massive waves and a storm surge that damaged Florida's Escambia Bay Bridge. Engineers in OSU's O.H. Hinsdale Wave Lab are testing a replica of the bridge deck to determine how it can be designed to withstand such forces. (Photo: Pensacola News Journal)

The forces that threaten bridges are not always visible to the naked eye, like a rusty beam or a semi-truck, or to a weather satellite, like a windstorm or a hurricane. Instead, they are distant, invisible and unpredictable.

T-beams) with mega-forces and maxi-stressors. They pound them with hydraulic cylinders, pummel them with tons of rolling force, and subject them to extremes of heat and cold, down to minus 13 degrees Fahrenheit (hence the need for Arctic parkas). They even use sound to detect invisible defects. By listening to acoustic emissions, the researchers can analyze internal noise sources and pinpoint structural weaknesses.

"We're doing some things that no lab in the world has ever done before," says Higgins. "For instance, we built a moving load simulator that can actually roll, acting like a truck traveling across full-size girders. We found that a moving load affects the bridge structure differently than a single load pushing at one spot. The internal stresses change as the load moves across."

More than 70 of these full-size T-beams, the workhorses of concrete bridges, have been subjected to loads as heavy as 500,000 pounds (the equivalent of about 100 SUVs) in the OSU lab. The idea is to make them fail, determine how to predict that failure and then figure out how best to fix them. "I'm all about existing structures, how to squeeze more life out of them, figure out how much strength is left in them and quantify the risks associated with them," says Higgins.

As greater and greater force is applied, hairline cracks form at the concrete surface like networks of varicose veins. But causing a 26,000- to 40,000-pound hunk of reinforced concrete to crack is no mean feat. The researchers do it in several ways. To simulate the movement of continuous, everyday traffic (what engineers call "high-cycle fatigue"), the researchers apply millions of repeated bounces to the T-beams with a hydraulic cylinder. To imitate the impact of heavily loaded triple-tractor-trailer rigs ("low-cycle fatigue"), they apply a half-million pounds of downward pressure (a million pounds for the massive Goliath). To test the effects of temperature and shrinkage on strength, they pull the girders lengthwise, using as much as a quarter-million pounds of force.

Once cracked, some of the beams are mended. The purpose is to test the performance of both novel and existing repair techniques. Some are applied internally, others externally. The researchers inject epoxy and insert steel rods. They wrap cracked beams in sheets of a polymer, a composite material reinforced with carbon fibers originally developed for aerospace applications, that bonds to the surface and restricts the cracking like, he says, "a Band-Aid across a cut."

The lab-induced fissures mimic the fatigue cracks that inspectors have found on some 500 of Oregon's 1,800 concrete bridges, most of which date from the 1950s when President Dwight D. Eisenhower launched the Interstate Highway System. In 2000, ODOT hired Higgins and OSU's multidisciplinary Kiewit Center for Infrastructure and Transportation to help it assess the state-owned spans.

The result of the $1.5 million study was another milestone for Higgins and his team, one that produced a more accurate bridge assessment process and has already saved up to a half-billion dollars for the state. The breakthrough was twofold: better prediction of load capacity for existing bridge components and the development of a load-rating tool known as a "load factor" (a number that statistically represents the expected loading on the bridge). The research has produced the first state-specific load factors in the nation. By using actual traffic data in place of generic figures, the new load factors have brought unprecedented precision and specificity to Oregon's bridge rating process.

"Site-specific load factors are more refined because they are characteristic of a particular bridge site, route or jurisdiction," wrote former graduate research assistant Jordan Pelphrey (who now designs and fabricates bridges for Knife River in Harrisburg, Oregon) in a paper coauthored with Higgins. "They reflect the actual truck traffic and likely maximum loadings over the exposure period."

"Based on Professor Higgins' research, we were able to reduce the number of bridges that were required to be replaced or repaired," explains Bruce Johnson, state bridge engineer at ODOT.

In September, Higgins submitted written testimony to the U.S. House Committee on Science and Technology, calling on Congress to create "a national research center focused on safety evaluation of existing bridges that draws on expertise from across the country." Such a center, modeled after the National Science Foundation's Earthquake Engineering Research Center, would be "a logical and fruitful" nexus of university research and federal support, Higgins told the committee.

Wave Action

The forces that threaten bridges are not always visible to the naked eye, like a rusty beam or a semi-truck, or to a weather satellite, like a windstorm or a hurricane. Instead, they are distant, invisible and unpredictable.

On the seafloor deep beneath the Pacific is a 600-mile seam that bubbles and broods, unseen except by the giant clams and worms inhabiting the superheated, sulfuric waters. At this Cascadia subduction zone off the West Coast of North America, the Earth's crust is slipping, millimeter by millimeter, beneath the crumpled edge of the continent. Pressure is building, inexorably.

When this pressure next releases, as it does every few centuries, the violent quake it unleashes will most likely be followed by a train of water roaring toward shore at 600 miles an hour, inundating communities from Canada to northern California. At Newport on the central Oregon coast, tsunami warnings posted along the beach advise people to head for the hills when sirens blare, a graphic reminder of the offshore fault that could rupture at any moment.

Coastal bridges are vulnerable.

So while Higgins studies load stresses, other OSU engineers investigate wave forces. The cataclysmic 2004 tsunami that killed 230,000 people in Indonesia and neighboring nations caused Oregon highway officials to take a new look at bridge vulnerability along Highway 101. ODOT hired OSU to do a case study of the Spencer Creek Bridge on Oregon's main artery between Newport and Depot Bay.

After an experimental bridge girder has been pounded to the point of cracking, Higgins and his team investigate both internal and external methods of repair, such as injecting epoxy, inserting steel rods and wrapping them in sheets of carbon-fiber polymer. (Photo: Jim Folts)

Metropolitan Portland accounts for 14 of Oregon's 2,683 highway bridges. According to The Portland Bridge Book, *the Fremont (top) features the longest bridge span, 1,255 feet between supporting piers, in the state. (Photo: istockphoto.com, Lynn Morrow)*

Using blueprints of the bridge under construction at Spencer Creek, OSU engineer Solomon Yim ran simulations of three Cascadia quake scenarios on a state-of-the-art supercomputer. The professor of structural and ocean engineering, in collaboration with scientists at the University of Hawaii, used principles of fluid-structure interaction to estimate wave loads on the bridge design for each scenario.

"Although the inundation for two of the three scenarios is generally small because of the steep mountain slopes along the coastline," Yim says, "the third scenario could send floodwater deep into valleys and basins between mountain ridges, possibly as much as a mile up the Spencer Creek basin."

Yim stresses, however, that these results are preliminary and that specific recommendations for changes in bridge design are premature. Future supercomputer simulations and large-scale experiments in OSU's wave lab will lead to new design guidelines for tsunami-resistant structures down the road.

Making sure bridges can stand up to nature's most fearsome forces is the aim of yet another OSU investigation, this one undertaken by engineering professor Daniel Cox and funded by the Oregon Transportation Research and Education Consortium. In the same cavernous building that houses the Structural Engineering Research Lab, Cox is studying the 2004 failure of Florida's Escambia Bay Bridge during Hurricane Ivan. The I-10 bridge, whose design is typical of those on the southeastern coast, lost its superstructure (the highway deck) when the storm surge and waves washed over it.

"This is a first-of-its-kind test," says Cox, who directs the O.H. Hinsdale Wave Research Laboratory at OSU. "No one else has simulated hurricane-force waves on a large-scale physical model of an actual highway bridge."

A veritable pincushion of electronic sensors, the concrete-and-steel model will undergo the surging forces of life-like waves in OSU's flume, North America's longest hydraulic wave tank. When the data on horizontal and vertical loads, impact pressures and wave conditions are collected and analyzed, engineers will be better equipped to design hurricane-proof bridges to safeguard Gulf and East Coast residents, already braced for the next killer storm.

Trust in Trusses

Gusts, however, don't have to be hurricane-force to wreak havoc. The day a brand-new bridge in Washington state began to buck like a bronco, the 42-mile-per-hour winds were whipping around wildly but were well short of hurricane velocity. The year was 1940, and the 2,800-foot span — opened to traffic just four months before — had quickly earned the nickname Galloping Gertie for its rollercoaster-like motion.

Engineers were studying ways to stabilize the bridge. But they never got the chance. On that blustery July morning, as Gertie twisted like a corkscrew high above the Tacoma Narrows, motorists abandoned their cars and crawled to safety on hands and knees moments before the bridge broke apart. They watched as their vehicles (along with one hapless cocker spaniel named Tubby) plummeted into Puget Sound.

To this day, the wreckage of that engineering disaster rusts at the bottom of the narrows. The story of Galloping Gertie, legendary in the Pacific Northwest (you can see eyewitness film footage at www.pbs.org/wgbh/nova/bridge/tacoma3.html) is a cautionary tale known to every civil and structural engineering student.

ODOT engineer Gary Bowling has inspected thousands of bridges. He knows better than most what can go wrong and what's at stake. "When you're driving along the highway, you're putting your faith in people doing their job — the engineers, the inspectors, the maintenance workers," he says. "Surface hazards like potholes are visible and easy to avoid. You can drive around them. But bridge hazards tend to be hidden. I have yet to see a businessman or a soccer mom stop their car before crossing a bridge and get out to examine the substructure for signs of corrosion or faulty design."

Whether the focus is on fixing old structures or building new ones, on mitigating traffic loads or withstanding natural forces, OSU's research has one overarching goal: making bridges worthy of the public trust. terra

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Learn more about research in OSU's Kiewit Center for Infrastructure and Transportation at ***kiewit.oregonstate.edu***

Risk Versus Cost
The politics of safety

Nationwide, $1.6 trillion is needed over five years to rehabilitate infrastructure — roads, bridges, dams, airports and water systems — the American Society of Civil Engineers estimates. In weighing such investments, lawmakers also respond to the desire for low taxes, says Bill Lunch, OSU professor of political science. (Photo courtesy of OSU News and Communications)

For structural engineers like OSU's Chris Higgins, the Minneapolis catastrophe was less a jolt from the blue than a confirmation of a longtime certainty: America's aging system of roads and overpasses, once the envy of the world, is frayed and in danger of failing. Why have years of experts' warnings failed to mobilize citizens and their representatives to fully fund an overhaul of transportation infrastructure? Bill Lunch, chair of OSU's Department of Political Science, has devoted decades to observing and analyzing Oregon's political and public-policy scene. The professor, well-known to listeners of Oregon Public Broadcasting, shared his perspective with *Terra* magazine.

TERRA: If governments exist to keep people safe and functioning as a community, infrastructure seems to lie right at the heart of governments' *raison d'etre*.

BILL LUNCH: In a modern, industrial economy, that's right. Transportation and communication, along with provision of electricity, sewer, water — these are all basic public goods.

If infrastructure is so critical to commerce and community cohesiveness, why have we fallen so far behind in infrastructure maintenance?

BL: Most lawmakers know very well that we've got a very serious problem, and that we've got inadequate resources to deal with it. Oregon congressman Peter DeFazio, who chairs the House Subcommittee on Highways and Transit, has been warning for years that we're not spending enough on repairs, including reinforcing bridges so they're less likely to fall in the drink in case of an earthquake. The leaders are trying to lead. But they can only push so far if the public isn't supportive. That's the nature of democracy.

So do we have to wait until bridges collapse before the public takes notice?

BL: Not quite, but pretty close. Ours is a system that responds to crisis. Back in the '40s, for instance, Americans were very resistant to getting into World War II. It took the bombing of Pearl Harbor, a catastrophe of enormous proportions, to change public opinion. Most people have jobs to do and children to raise and leaky faucets to fix. They've got other things to worry about than whether the roads are falling apart. It's not the kind of issue that gets the juices flowing among the general public until the bridge falls down.

But when you ask people if they want safe roads and bridges, very few say "no."

BL: Sure. When public opinion pollsters show Americans a list of 100 services — transportation, education, environmental protection, public health, parks — and say, "Do you think the government should provide more, less or the same amount of these?" people say "more." Then a few minutes later, the pollsters ask the same respondents, "To pay for these services, do you think your taxes should be higher, lower, or the same?" and they say, "lower." People want to have their cake and eat it, too.

The anti-tax movement got a foothold in Oregon with Measure 5, the property-tax rollback of 1990. State services are still feeling its effects nearly two decades later, right?

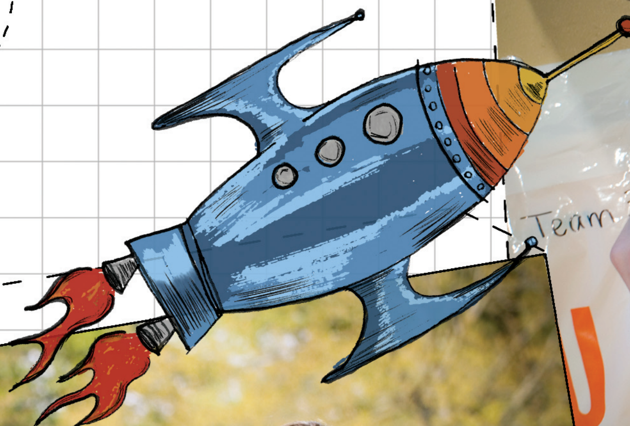
BL: Measure 5 was sort of like dropping a very large boulder in a relatively small pond. The waves that went out in terms of public finance were enormous. Oregon is a very low-tax state, ranking 44th in the nation for combined local and state taxes. Lower taxes equals fewer services.

If infrastructure is so vital, yet taxes are so reviled, what's to be done?

BL: Timing is everything. In Washington state where they have lots of bridges, the legislature passed a 9-cent increase in the gas tax in 2004, to be phased in over several years. Opponents referred it to the voters. All the analysts assumed that the tax increase was toast. But the question was put to the voters in November 2005, right after Hurricane Katrina, which had shown people, very dramatically, that we are social animals and we live with each other for better or worse. And if you have a catastrophe and the government doesn't respond well, which it did not, there are horrible consequences for lots of people. It was a very sobering object lesson. Well, surprise, surprise, the voters sustained the gas tax, giving them a substantially larger pot of money for infrastructure, including bridges.

— Lee Sherman

For a fuller version of the interview, go to *oregonstate.edu/terra*



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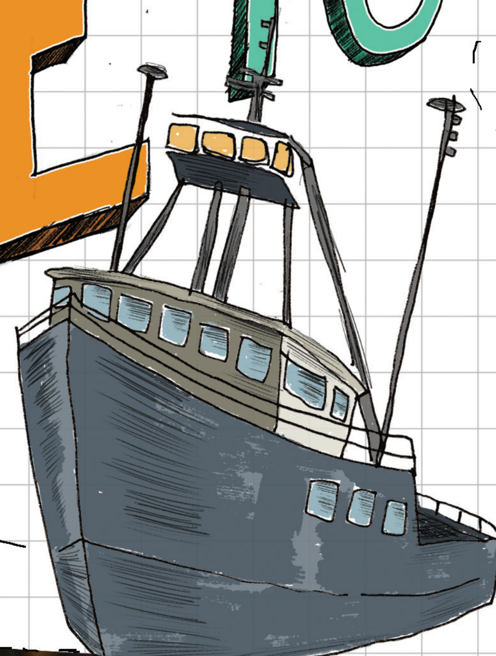

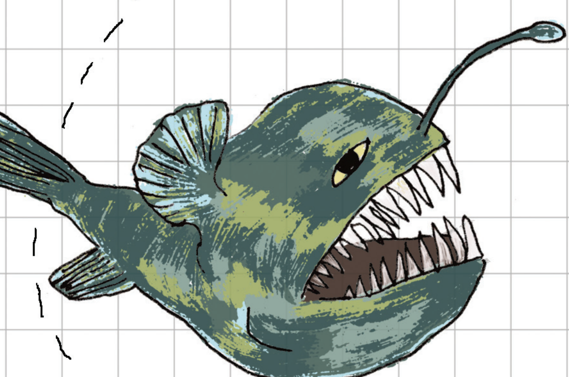

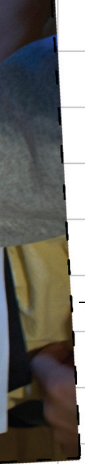

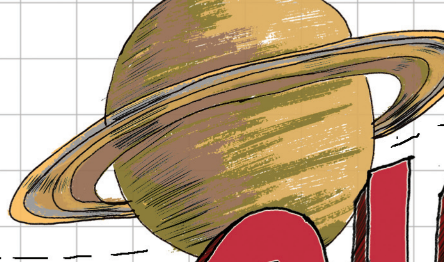

SCIENCE

BY LEE SHERMAN · PHOTOS BY KARL MAASDAM · ILLUSTRATIONS BY SANTIAGO UCEDA

Strange, alien environments — far-away planets, fathomless seas, shadowy forests — figure in countless daydreams. What child hasn't imagined herself at the controls of a futuristic spacecraft? Or at the prow of a wave-tossed vessel? Or on the trail of a secretive beast?

Exploiting kids' universal yen to explore remote and exotic places, a noted OSU outreach program entices underserved students to consider college. The mostly low-income, rural, minority youngsters who sign up for the Science and Math Investigative Learning Experiences (SMILE) Program meet face-to-face with scientists, engineers and researchers. In teams, they simulate galactic travel, oceanic voyages, ecological problem-solving and all sorts of other mind-expanding projects, both at their schools and on the OSU campus. With guidance from K-12 teachers and college-age mentors, they might, for example, design a self-contained space capsule. Or locate a lost ship using GPS tracking devices. Or study satellite maps for evidence of toxic algae blooms.

"Fun, hands-on projects about astronomy, oceanography and ecology make students comfortable with science so they're not afraid of it," says Eda Davis-Lowe, SMILE director in the College of Education. "Science and math are essential for college admission. They are the gatekeepers to higher education." By training teachers, engaging students in learning adventures and offering college scholarships, SMILE leads students through the gates.

Modules on Mars

Last spring, two cohorts of boisterous students from a dozen middle schools teamed up noisily around tables in the OSU Memorial Union to contemplate the constraints of living on Mars. These 192 adolescents from across Oregon, from Siletz Valley on the Pacific Coast to Nyssa and Ontario on Idaho's edge, considered factors such as raging sandstorms, dangerous sunrays, poisonous air, scarce water and limited power as they designed "crew modules" capable of supporting four to six astronauts for 600 days on the Red Planet.

Giggles and groans erupted when they learned that urine is a source of drinking water in NASA's recycling system, along with "grey water" (leftovers from sinks and showers) and condensation (breath vapor). One of SMILE's college-age mentors, OSU mechanical engineering major Ashley Swander of Salem, simulated the process on a small-scale replica. Then she let the kids come up and operate the manual pump.

At "briefing stations" located around the room's perimeter, other OSU mentors answered kids' questions about coping with Martian environmental conditions, power systems and daily living challenges. Steve Carpenter, a student in the Department of Science and Mathematics Education, engaged the middle schoolers with questions designed to provoke higher-order thinking about capturing and purifying water. "In outer space, water's like gold," he reminded a seventh-grader named Amy.

For Ontario sixth-grader Ana, a straight-A student aiming for medical school, the "different ways you can recycle water" was the day's most intriguing lesson. Since joining SMILE in fourth grade, her eyes have been opened, she says, to "so many opportunities." Ana's Mars module team, *Las Cinco Estrellas* (The Five Stars), included her pal Natalie, an aspiring lawyer. Together, the two Hispanic girls talked excitedly about the program's challenges, teamwork, creativity, firsthand exposure to university life and fun (evidenced by the many "whoops!" and high-fives gyrating through the room).

"We get to ask more questions and get more explanations," Natalie says.

Ana sums it up this way: "SMILE gives us a better chance."

Rescue at Sea

Lured by such irresistible mysteries as Mars' red rocks, Earth's opaque oceans and nature's intricate web, nearly 5,000 students from 12 Oregon school districts have participated in SMILE during its 20-year history. More than 300 classroom teachers have received professional development to lead weekly SMILE Clubs, where kids take field trips and dig into projects like designing a waterwheel, a catapult, a laser communications system or a crane for hazardous materials. Family math-and-science nights give parents a chance to join in. Once a year, high-school scholars come to OSU and nearby Western Oregon University for a mega-event, a multi-district weekend Challenge. They not only take part in projects like the mission to Mars, developed by engineers and researchers, they also get to meet those very same scientists and hang out with college kids who can give them the skinny on campus life. All of this adds up to what former SMILE Associate Director SueAnn Bottoms calls "education beyond the diploma."

Whatever project they tackle, all the fourth- through 12th-grade SMILE participants take away one overarching lesson: Math, science, engineering and technology aren't just dry theories stamped on the pages of boring textbooks. Rather, these fields, windows on challenging and lucrative careers, have exciting applications in the real world.

One of those applications is search and rescue. Last spring, Madras senior Nick Katchia was one of 136 high schoolers tasked with finding a mock ship lost on the high seas. Learning about GPS technology, navigation and remote sensing was cool, he says. But what really lit him up was the ocean itself. "I've never seen the ocean," reveals this young man from Oregon's landlocked high desert, a six-year SMILE participant. "There's a lot more to the ocean than I realized — currents, deep-sea creatures, plankton blooms."

His buddy, junior Daniel Serrano, was awed by the economics of oceanography. "I was surprised by the cost of a research voyage, from $3,000 per day to $30,000 per day," says the honor student. "That's a lot of money!" Then, sounding very much like a concerned taxpayer, he adds, "I hope they know what they're doing."

Daniel was jarred, too, when he learned about the tons of junk afloat on the Earth's oceans. "The garbage stays in the ocean forever," he explains. "It just keeps going around in circles."

Oceanographers from the Coast Guard and the National Oceanic and Atmospheric Administration were on hand to guide and prompt the young scientist-wannabes as they battled imaginary 22-knot winds to locate the fictional Juan Marichal, a merchant ship adrift somewhere in a 6,000-square-kilometer area of the Pacific (in reality, they were looking for a wooden dowel hidden in the grass on the MU Quad). NOAA scientist Luke Spence shared his expertise in fisheries and satellite imaging. "We use real nautical charts and real data on currents and temperatures to teach the students about range, bearing, wind direction, speed, all the forces that affect the ship," says Spence, who is based in Monterey, California. "We try to make the project as real as we can."

Stratospheric Expectations

The longer students stay in SMILE, the greater their academic success. By the time they've spent at least four years in SMILE, their chances of high school graduation are better than 90 percent. That figure eclipses Oregon's overall graduation rate of 75 percent. But the number is made even more impressive by the fact that SMILE students represent groups — Hispanic, American Indian and low-income whites — whose educational careers are too often cut short.

Cool projects are unquestionably one key to SMILE's track record. But there's another factor, one that's more subtle but at least as powerful: believing in these kids. An invisible but insidious form of racism — low expectations for children of color — permeates many public schools, says Davis-Lowe, who grew up in the segregated South. For her, infusing every child's heart with sky's-the-limit aspirations is the program's greatest mission.

"From day one," Davis-Lowe says, "we treat them all as future college students." terra

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See photos and a schedule of upcoming SMILE events at *smile.oregonstate.edu*

Priming the Pump

The Science and Math Investigative Learning Experiences Program's funding comes from state, federal and private sources in roughly equal parts. SMILE's many partners help to drive project content and design. Major supporters and program collaborators include:

- Howard Hughes Medical Institute
- Oregon Space Grant Consortium (National Aeronautics and Space Administration)
- University-School Partnerships Program (U.S. Department of Education)
- Cooperative Institute for Oceanographic Satellite Studies (National Oceanic and Atmospheric Administration)
- Science and Technology Center for Coastal Margin Observation and Prediction (National Science Foundation)
- Oregon Engineering and Technology Industry Council (ETIC)

Air Beneath Their Wings

BY NICK HOUTMAN | PHOTOS BY JIM FOLTS

Five undergraduates — five dreams.

Blake Kelley sees a bright future for nuclear power and is learning all he can about reactor designs.

For Hiromi Omatsu, the future is in technology that enables elderly people to stay in their own homes.

Writing is Stephen Summers' love. He publishes poetry and fiction in OSU's student literary magazine *Prism* and hopes to make a living as an author.

After studying the molecular machinery in living cells, Laura Marquez-Loza wants to go to medical school.

And Nikki Marshall's research with seeds has inspired her to work in environmental restoration and organic farming.

The common thread? Private scholarship support has enabled each to stay in school and pursue his or her goals.

Carmen Steggell, professor in the Department of Design and Human Environment, knows how much that support matters. The recipient of OSU's Faculty Teaching Excellence Award has seen high-achieving students drop out of school for lack of money. And she has seen students stretch financially to participate in research that opens career doors.

At OSU, students receive about $12 million in private support annually through scholarships, fellowships and other funds managed by the OSU Foundation. Nevertheless, says Steggell, rising expectations (bring a laptop to class; buy software and the latest textbooks) and tuition rates strain student budgets. The trend is national. According to a recent U.S. Department of Education report, "... financial barriers will keep nearly two million low- and middle-income college qualified high school graduates from attending college." (*A Test of Leadership*, www.ed.gov/about/bdscomm/list/hiedfuture/reports.html)

Steggell sees the local impact. "You can't be frugal in the ways that you used to be frugal," she says. "And many of the students I work with are juggling work schedules around their class schedules. For most, it's going to school money."

The foundation has set a $100 million fundraising goal for a student support endowment in the Campaign for OSU.

Here, in their own words, students describe their research and how scholarships have helped them.

HIROMI OMATSU

Year and discipline: Senior, Design and Human Environment

Hometown: Kawagoe City, Saitama, Japan

Scholarship: The University Research Awards Program in the College of Health and Human Sciences helped to pay my tuition. Without it, I would have had to work at other jobs. (Hiromi also received a LIFE Scholarship, supported by OSU's healthy aging research initiative.)

Inspiration: My parents, who allowed me to decide my own future, and my two brothers and my sister (flute repairer, computer systems engineer and embroidery expert), who created their own careers.

Career goal: To conduct research on or to design housing systems that enable elderly people to enjoy life in their own homes.

Academic focus: The technology that people use to monitor health, alert them to medications, detect movement and provide security.

Laura Marquez-Loza

Year and discipline: Senior, Wood Science and Engineering

Hometown: Mexico City, Mexico

Scholarship: The Richardson Scholarship allowed me to go to school. If it had not been for that I would have been unable to pay for college.

Inspiration: My parents, because they have overcome many obstacles together and achieved so much. My grandma has also been an inspiration because she was very independent and ran a successful business to help support her seven children.

Career goal: To apply to medical school and pursue a career in health-related research.

Academic focus: In a plant virology lab, I learned laboratory techniques (how to extract RNA). Last summer, I learned to analyze wood from transgenic poplars, performing macerations and working with imaging techniques to measure fiber lengths.

Blake Kelley

Year and discipline: Senior, Nuclear Engineering

Hometown: Grants Pass, Oregon

Scholarship: This year I've received 11 scholarships ranging from $500 to $2,500. The Alan H. Robinson Scholarship cemented my financial security, enabling me to focus on schoolwork and research. This also gives me time to prepare for graduate school and a summer internship.

Inspiration: People who teach math and science: my adviser, Todd Palmer; my high school physics and chemistry teacher, Ron Rollins; and my high school calculus teacher, Martin Connelly.

Career goal: Doing research on spent fuel storage, reactor design or radiation detection. I would like to live in an era when the public embraces nuclear power as a clean, long-term energy source.

Academic focus: Using new methods to simulate the response of radiation detectors.

Stephen Summers

Year and discipline: Senior, English and Philosophy

Hometown: Canby, Oregon

Scholarship: The Ronald P. Lovell Presidential Scholarship brought me to Oregon State. Without the funding, I wouldn't have been able to come here and dedicate myself to my studies.

Inspiration: Writers inspire me, because they manage to take some memory from their own lives and transmit it across time and space into something that touches me. My parents inspire me in their wholehearted dedication to my brothers and me. Also, Jesus Christ.

Career goal: To teach literature at the university level. Eventually, I hope to support myself writing crime novels and making public appearances.

Academic focus: I write poetry for myself and fiction for others. I publish contemporary poetry and short fiction in *Prism* (OSU's student literary magazine).

Nikki Marshall

Year and discipline: Senior, Bioresource Research

Hometown: Portland, Oregon

Scholarship: The Jaworski Scholarship has opened up opportunities for me in sustainable, organic farming and ecosystem restoration. Financially, it has enabled me to pay for childcare for my daughter. (Marshall has also received the E.R. Jackman Scholarship, support from the Oregon Seed Trade Association and an award from the American Seed Trade Association with Future Seed Executives.)

Inspiration: My daughter Trinity is 8 years old. She is always asking questions and giving me hope.

Career goal: To own a farm and to restore lands harmed by invasive species or toxic chemicals.

Academic focus: I have been learning how to control seeds through heat treatments and consumption by beetles. Seeds of invasive species and other weeds pose problems for agriculture and environmental restoration.

To learn more about what scholarship support means to OSU students, see *campaignforosu.org/historic_campaign/student_stories.html*

The spread of American beach grass could raise risks for structures along the Northwest coast, such as these new houses at Ocean Shores, Washington. (Photo: Phoebe Zarnetske)

Invaders in the Dunes

Unnoticed by most beach-goers, a showdown is under way in Oregon's coastal dunes, and the winner could pack increased risks for coastal property, especially during winter storms.

OSU scientists have documented a slow but steady takeover by American beach grass (*Ammophila breviligulata*), an invasive species from the East Coast and Great Lakes. They have found that protective "foredunes" covered by the new species are only about half as high as those created by the European species of grass (*Ammophila arenaria*), another non-native that was dominant. And they are initiating research to understand what gives the American variety the edge and what that might mean for coastal property owners and native plant restoration.

The takeover has already occurred from Ocean Shores, Washington, to Pacific City, Oregon, and it's continuing. "This decrease in dune height may translate into a significant decrease in coastal protection from storms and tsunamis," says Eric Seabloom, an OSU assistant professor of zoology.

Historically, the dunes were more open than they are today, hosting plants such as wild rye and relatives of morning glory, buckwheat and other wildflowers. The European grass has stabilized Oregon dunes since it was first introduced for that purpose around 1900. "It did its job extremely well," says Sally Hacker, OSU associate professor of zoology and an expert on estuaries. "Without it, the sand would cover towns and roads."

It was so successful that by the 1930s it had spread along the entire Oregon coast and created an extensive "foredune" system, large protective sand hills in front of almost every sandy beach. These dunes can provide significant protection for homes, roads, towns and other infrastructure, and serve as a barrier against flooding during storm surges.

The second invasion, by American beach grass, went practically undetected for 50 years. Introduced near the mouth of the Columbia River in the mid-1930s, also to stabilize beaches, it out-competes its European cousin. It wasn't until a survey in the late 1980s by Seabloom and a colleague at Evergreen State College that scientists realized how far it had spread, south to Tillamook Head and north to the Olympic Peninsula.

Coastal surveys have now determined that from Pacific City north, American beach grass has nearly replaced the European variety. "Lower dune heights, increasing wave heights that have been observed over the last 50 years and global climate change could create a scenario in which the dunes no longer serve a coastal protection function," Hacker says.

With funding from Oregon Sea Grant, zoology Ph.D. student Phoebe Zarnetske of Storrs, Connecticut, is teasing out the story behind these trends. In experiments at the Hatfield Marine Science Center in Newport and at the O.H. Hinsdale Wave Research Laboratory on the OSU campus, she is subjecting the two grasses to varying rates of sand deposition to see which one thrives. She has visited practically every sandy beach in Oregon and Washington to survey beach grass conditions. And as a student in OSU's Ecosystem Informatics IGERT program, she will develop a mathematical model to explain how this dynamic system is changing.

Beyond the protection concerns, there are other ecological issues in play as well. While the foredune system created by European beach grass is good for coastal landowners, it is not so good for endangered native plant species and the federally threatened Western snowy plover. As more sand accumulated in growing stands of the European grass, the land behind the dune tended to get turned into wetlands and forest habitats.

"The willows and other trees and larger shrubs you often see behind the dunes are an indication that wetlands are being formed in the mini-valley behind the dunes," says Hacker.

As European grass advanced, beach habitat disappeared, taking with it the plovers' critical nesting grounds. The southward march of the American beach grass could reverse the trend.

Hacker and Seabloom are also working with Peter Ruggiero, a coastal geomorphologist in the OSU Department of Geosciences, to understand how coastal sediment supply and nearshore oceanographic conditions influence beach grass competition and the coastal protection capabilities of dunes. The researchers plan to meet with coastal property owners in 2008 to discuss the results of their work.

– Nick Houtman

OSU ranks No. 1 in conservation biology, according to the journal ***Conservation Biology***. Learn about related research in the Department of Zoology at ***zoology.science.oregonstate.edu***

Scientists to Bark Beetle: “No Vacancy”

You think it’s difficult to master a complex foreign language like Chinese or Greek? Try learning how to speak “bark beetle.”

After about 30 years of study, researchers at OSU have done exactly that. Along with U.S. Forest Service colleagues, they’ve figured out what a particular pheromone is communicating to Douglas-fir bark beetles and now use that language to help protect high-value trees on thousands of acres across much of the West.

The pheromone, known as MCH, has been proven effective. The U.S. Environmental Protection Agency has approved its use, and two private companies are marketing it for application in such places as campgrounds, resorts and residential areas. It represents another success story in the development of chemical cues and signals to help resist insect attacks and epidemics.

“This system works like a charm,” says Darrell Ross, associate professor of forest science. “We’re definitely communicating with the bark beetles, and the result is we now have a way to protect some of our most valued trees. That’s pretty exciting.”

Douglas-fir bark beetles are opportunistic pests that need recently killed trees to breed and reproduce. Although always present, they rarely harm healthy forests. They often come in after forest disturbance events such as wildfire, wind damage or other pest epidemics, and take advantage of the dead trees or finish killing weakened ones. Once an infestation reaches high levels, though, the pest is forced to attack live trees more than usual in order to support the population. It can cause major damage.

But in the 1970s, OSU and Forest Service scientists identified MCH. They then spent almost 30 years learning what it does and how it can be used to prevent beetle infestations. Essentially, this pheromone tells a Douglas-fir bark beetle, “This tree is already taken.”

“When bark beetles are looking for a place to lay their eggs, they don’t want to go to a tree that’s already heavily infested with their own species, because food might be limited,” Ross says. “So the insect has a communication pheromone that alerts other beetles to its presence. This anti-aggregation pheromone is like a no-vacancy sign. It tells individual beetles to go somewhere else, this spot is already spoken for.”

Another pheromone has also been identified that attracts the beetles into traps, but it is less effective and not as widely used.

Many Pacific Northwest forests can survive years of defoliating attack by other insect pests, such as the spruce budworm or Douglas-fir tussock moth. But bark beetles, whose scientific name, *Dendroctonus*, actually means “tree killer” in Latin, often finish the job and can cause high levels of mortality in an infected forest.

The anti-aggregation pheromone used in this protection program is particularly effective, scientists say. It accomplishes the forest management goal nearly 100 percent of the time, and studies have shown that it’s environmentally safe, as well as inexpensive.

The technique also lends itself well to the concept of integrated pest management, where various approaches — such as silviculture, thinning, harvest of wind-thrown timber and use of pheromones — are all used together to improve forest health more than any one approach could by itself. Continued studies will work toward techniques that allow fewer pheromone dispensers per acre and further reduce cost of use.

“These are very powerful chemicals that the beetles use for specific communication purposes,” Ross says. “We continue to learn more about pheromones and now understand that insects and other animals use a whole complex of odors to communicate and make behavioral decisions. The hard part is learning how to speak that language.”
– David Stauth

Douglas-fir bark beetles can kill healthy trees, but a commercially available pheromone identified by scientists repels the insects. (Photos: Edward H. Holsten, USDA Forest Service, Bugwood.org)

To learn more about research in the Department of Forest Science, see *www.cof.orst.edu/cof/fs*

Strong Medicine

Oregon leads the nation on many tough bioethical questions

by Lee Sherman | Illustration by Scott Laumann

In 2005, the Terri Schiavo drama riveted the nation with a cast of thousands: a feuding family, legions of lawyers and judges, dueling neurologists, irate clergymen and rowdy picketers. Politicians plotted and offered legislation, and President George W. Bush flew from Crawford, Texas, to Washington, D.C., in the middle of the night to sign emergency legislation blocking removal of a feeding tube from the stomach of a 41-year-old Florida woman in an irreversible coma.

"I can't imagine a Terri Schiavo case happening in the state of Oregon," says OSU Professor Courtney Campbell, a nationally known religious-studies scholar and bioethicist. "Somehow, we're able to get to consensus on these difficult health-care issues without having them land in the courts and media headlines."

Campbell credits Oregon's pioneer spirit for fostering a "social laboratory" for reasoned decision-making on medical and ethical issues. The settlers who braved the wilds of the West were freethinking risk-takers who rejected the Eastern establishment's rigid norms, he says. The "Oregon ethos" of today flows from that frontier heritage, spilling into unmapped territories of science, medicine and personal choice, a brave new world unimaginable when the wagon trains rattled over the Oregon Trail.

Terri Schiavo became the public face of a technological revolution in medical research, along with such notables as Dolly the sheep and the "Snowflake babies." The scientific strides behind these media stories — the life-support machines that maintained a brain-dead woman, animal cloning that produced a Scottish ewe and in-vitro embryos that led to a small subset of adopted children — are dazzling in their technical brilliance.

Equally breathtaking are the ethical dilemmas they raise. Today's medical choices, confronted privately at hospital beds and collectively at ballot boxes, bump into the deepest mysteries of human existence. That's where ethics experts like Campbell come in, to help lawmakers, doctors, hospital administrators, hospice workers and ministers align time-honored values with ultra-modern tools that just a few years ago were sci-fi fantasies. Bioethics, which emerged as a discipline with the advent of futuristic medicine in the 1970s, exists at the nexus of humanity's oldest ideas and newest inventions, its profoundest hopes and deepest dreads. The stakes couldn't be higher: life, death, suffering and the meanings we give them.

Cells and Selves

It is at this tangled crossroads, the intersection of science, practice and belief, where Campbell spends his intellectual life. "We can explain the circumstances of, say, embryo development or terminal illness medically and scientifically," he says. "But deciding what those things mean in an individual's life, or what they should mean for a culture and how we should respond to them in terms of medical practice, brings in deep-rooted values and deep-rooted worldviews." Bioethics is, by definition, a multidisciplinary enterprise that causes strange bedfellows (philosophers and researchers, doctors and pastors, hospice workers and assisted-suicide advocates) to hunker down for dialogue and problem-solving.

This dialogue takes Campbell from the classroom (where his popular courses fill up fast) and the humble chaplaincy of a Corvallis hospital all the way to the corridors of power in Washington, D.C. From 1997 to 1998, he was a special consultant to President Clinton's National Bioethics Advisory Commission and contributed two papers about religious values, one on human cloning and the other about research on human tissues.

Whether he's sitting on a national commission, writing a journal article, advising a community-based health-care organization or mediating campus controversies on emergency contraception and animal care in research labs, Campbell is definitely not an ivory-tower philosopher.

"In the field of medical ethics," he says, "intellectual questions are being worked out at a very practical level, a level that often means the difference between life and death for people."

Oregon Values

It was Oregon's innovative solutions to these difficult issues that lured Campbell west in the early 1990s. While finishing his Ph.D. in religious studies at the University of Virginia, he took a research position at the Hastings Center, the nation's first biomedical ethics think tank. There, he encountered ER physician and Oregon legislator John Kitzhaber, then president of the state Senate, and learned of Oregon's seedbed status on difficult health-care issues. Oregonians had, for instance, initiated the national conversation known as the Community Bioethics Health Decisions Movement, which convened "citizen parliaments" probing health-care values. They were about to launch the innovative Oregon Health Plan for the uninsured poor. And they were beginning to ponder the toughest end-of-life issues, a debate that culminated in the nation's first (and only) physician-assisted suicide law, which allows dying patients to hasten their own death with prescription drugs. A series of blistering legal battles ended in 2006 when the U.S. Supreme Court upheld the Death With Dignity Act.

In November, Oregon voters marked the 10th anniversary of their hard-won right to speed the end of terminal illness. About 300 Oregonians, roughly 30 each year, have chosen to forego the wracking pain of late-stage disease (and, for many, the shame of losing bowel and bladder control) by swallowing a lethal draught of prescribed sedatives.

> "Oregonians value quality of life over sanctity of life. They also value prevention over high-tech interventions." - Courtney Campbell

"Oregonians value quality of life over sanctity of life," Campbell notes. "They also value prevention over high-tech interventions. And they care about equitable distribution of health-care resources."

The 2008 presidential campaign has once again thrust health care into the center of public discourse. Oregon stands to play another bold role as Americans rethink rising costs and declining access. Kitzhaber, who spearheaded the Oregon Health Plan before serving as governor from 1994 to 2003, is leading the reform-oriented Archimedes Movement. Based on grassroots consensus around core principles, the movement aims to radically transform health care, first in Oregon and then across the nation. In the simplest terms, Kitzhaber envisions "a system that we can afford, that includes everyone and which produces health."

Says Professor Campbell: "The most important question in medical ethics today is ensuring access to a basic level of health care for all citizens. So Kitzhaber's efforts are as pioneering in the 21st century as they were in the 20th century."

Searing Scenarios

Unlike the Schiavo case, most of the wrenching quandaries doctors and families face are resolved quietly in hospital corridors or family counseling, Campbell notes. Often, these questions come before hospital ethics committees, which are charged with helping patients and physicians confront choices that are shrouded in the gray veils of conscience and faith and whose alternate outcomes may seem equally awful. "These decisions are messy," Campbell says. "Really messy."

OSU philosophy Professor Courtney Campbell challenges students to think about complex bioethical issues facing families and medical practitioners in an increasingly high-tech world. (Photo courtesy of University Marketing)

In discussions and workshops with students and community members, Campbell lays out the kinds of real-life scenarios that challenge ethics committees every day:

- A Down syndrome baby needs corrective surgery on its esophagus to save its life, but the parents refuse the operation
- A 27-year-old former U.S. Air Force pilot and athlete who was severely burned in an explosion refuses treatment and asks to go home to die
- A very short 11-year-old boy and his mother want him enrolled in a study of HGH (genetically engineered human growth hormone) in hopes that he can reach normal height; the doctor doesn't view short stature as a disease and is uncomfortable with the experimental treatment
- The parents of an accident victim in a persistent vegetative state want her feeding tube removed

This last scenario raises, once again, the specter of the Terri Schiavo tragedy-turned-travesty. Here at the end of the Oregon Trail, the progeny of pioneers have avoided a Schiavo-like spectacle. In fact, in the 30 years since the "living will" (now called an "advance directive to physicians") came to Oregon, not one end-of-life case has been litigated here, Campbell says. Meanwhile, researchers at Oregon Health & Sciences University are blazing trails in cloning primates and other animals, as well as advocating advances in stem cell research, more evidence of Oregon's frontlines stances on controversial issues.

"In this state, we've largely decided that we trust physicians and patients and families to make those decisions without the interference of government or religious authorities," he says. "We have a spirit of toleration, even when we disagree. We're willing to live together peaceably without a great deal of animosity toward each other.

"That," he concludes, "is an enormous cultural and social achievement." terra

Read Campbell's lecture, "Brave New World: Soma, Shakespeare and Suicide: The Terrors of Techno-Utopia," at ***oregonstate.edu/cla/philosophy/faculty/Campbell***

First Line of Defense

Last fall's announcement that virulent antibiotic-resistant staph infections had killed almost 19,000 patients in American hospitals and nursing homes in 2005 didn't surprise George Allen. With colleagues David Bearden and Mark Christensen, the assistant professor in the OSU College of Pharmacy studies antibiotic effectiveness.

He focuses on a class of broad-spectrum antibiotics known as fluoroquinolones, which includes more than 30 drugs used against infections such as Legionnaires' Disease, gonorrhea and hospital-acquired pneumonia. Some are used to treat methicillin-resistant *Staphylococcus aureus*, or MRSA, the culprit behind the Centers for Disease Control and Prevention announcement, and related strains known as community-associated MRSA (CA-MRSA).

CA-MRSA is more susceptible to a range of antibiotics than is hospital-acquired MRSA, says Allen. But, the optimal antibiotic for CA-MRSA infections is unknown. Moreover, the future risk of resistance to the fluoroquinolones and other antibiotics is poorly understood.

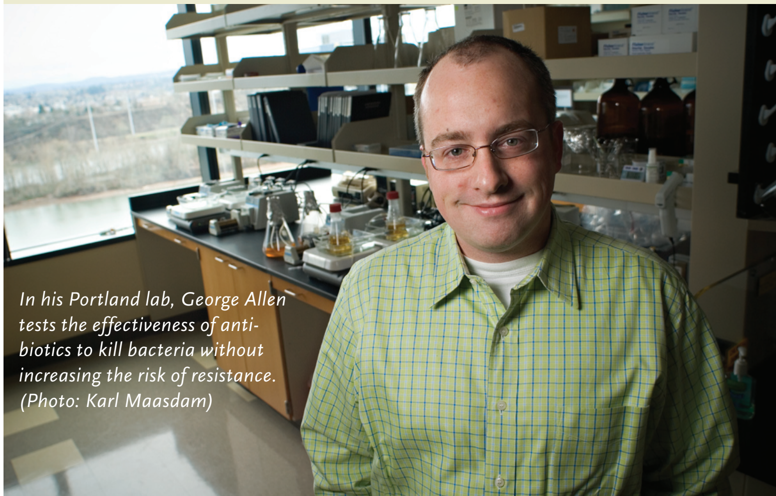
So in his lab, Allen and his students pump varying levels of antibiotics into solutions that contain infectious bacteria. For each antibiotic, they calculate the kill rate and test for the presence of newly acquired resistance. Using a novel concept called the mutant prevention concentration, they calculate the lowest effective dosage that will kill bacteria and avoid causing mutations that lead to resistance.

Allen has found that the fluoroquinolone moxifloxacin is effective in reducing further resistance in a certain strain of CA-MRSA, results that he presented at the 2006 annual meeting of the Society of Infectious Diseases Pharmacists. At the 2007 American College of Clinical Pharmacy annual meeting, one of Allen's former doctor of pharmacy students, Cynthia Hankins, received the Best Student Poster award for her work on *Neisseria gonorrhoeae*, the bacterium that causes gonorrhea, for which few effective treatments exist.

Allen, Bearden and Christensen are also evaluating the effectiveness of a topical antiseptic, StaphAseptic, developed by Tec Laboratories of Albany, Oregon. They have found that StaphAseptic is more effective than two commonly available topical disinfectants against CA-MRSA.

– Nick Houtman

Watch George Allen demonstrate antibiotic testing in his lab at *pharmacy.oregonstate.edu/faces*



In his Portland lab, George Allen tests the effectiveness of antibiotics to kill bacteria without increasing the risk of resistance. (Photo: Karl Maasdam)

A Drink to Your (Bone?) Health

(Illustration by Steven Lefcourt)

Moderate alcohol consumption in adults can have health benefits. It can reduce the risk of heart disease, stroke, gall-stones and maybe diabetes. Russell Turner, Gianni Maddalozzo and Urszula Iwaniec of OSU's Bone Research Laboratory could add osteoporosis to that list.

Studies with animals have found that the equivalent of five to 10 drinks per week can have beneficial effects on the skeleton. With support from the National Institutes of Health and the John C. Erkkila, M.D., Endowment, they hope to conduct the first-ever controlled study on alcohol and bone density in post-menopausal women.

Iwaniec and Turner co-authored a recent report on a drug that shows promise as a treatment for breast cancer and metas-tases to bone. The influence of alcohol consumption on bone density has also been a major focus of their work.

"We're not doing this with the idea of advocating alcohol consumption for the prevention of osteoporosis," says Turner. "But essentially half of Americans drink. And out of that half, 80 percent drink in the moderate range. The question is, Are they getting any skeletal benefit from it?"

So, starting in 2008, the Bone Research Lab will seek up to 50 female volunteers to participate in a six-week pilot study. To be eligible, subjects must routinely drink five to 10 "standard" (defined by the U.S. Department of Agriculture as 12 ounces of beer, 5 ounces of wine or 1.5 ounces of 80-proof distilled spirits) drinks per week. They must be post-menopausal and not be taking hormone replacement therapy or any other medications that would influ-ence bone.

The study will require subjects to stop drinking alcohol for a period of two weeks and then to resume their regular routine. Blood and urine samples will be collected four times during the study and analyzed for biomarkers of bone resorption (a normal process in healthy bones). Bone density scans of the whole body, hip and spine will also be included.

In rat studies, moderate alcohol intake has been as effective as some prescription drugs in lowering elevated bone turn-over (replacement of old bone with new bone). Elevated turnover is responsible for bone loss and reduced bone quality in post-menopausal women. "It's impor-tant because if in fact you do have an advantage, you may not have to take drug therapy at all or won't need to take it until later in life," says Turner. On the other hand, excessive alcohol consumption is known to reduce bone density.

Bone density reaches a maximum in young adults and reflects a balance between normal bone formation and loss. Estrogen helps to maintain bone mass, but after menopause, estrogen levels drop and bone resorption increases, resulting in a net loss.

Nationally, 80 percent of people diag-nosed with osteoporosis are post-meno-pausal women. Care for people who have suffered osteoporotic fractures cost an estimated $18 billion in 2002, according to the National Osteoporosis Foundation.

– Nick Houtman

To learn more about research in the Bone Research Laboratory in the College of Health and Human Sciences, see ***hhs.oregonstate.edu/nes/research/bone-lab.html***

Breaking Through
Researchers take it to the marketplace

When Larry Plotkin took a buy-out package from Hewlett-Packard in 2005, he aimed to start a new business in the mid-Willamette Valley. He was familiar with OSU research on transparent transistors, algae-generated biodiesel and microbial fuel cells. "This is world-class stuff," he says. And he felt that the potential for new products based on OSU research was "so underappreciated." It was time, he thought, to spin research into gold, to create companies that provide jobs and a sustainable future.

As a volunteer with the nonprofit Business Enterprise Center in Corvallis, Plotkin had helped startup companies get their feet on the ground. And he knew that OSU's Office of Technology Transfer works with scientists and engineers to commercialize their research results. So he contacted then-director Craig Sheward, who arranged for Plotkin to meet Les Fuchigami, an emeritus professor of horticulture and an expert in plant stress physiology. With OSU electrical engineer Tom Plant and graduate students in horticulture and engineering, Fuchigami had worked for nearly 10 years to develop a new way to monitor growing crops with speed and precision. Better information about plant stress could help farmers, as well as orchard and nursery managers, improve crop quality and save money.

Today, Plotkin and Fuchigami are chief executive officer and chief technology officer respectively of Precision Plant Systems Inc., along with Dave Persohn, chief financial officer, and Ping Hai Ding, chief scientist. They founded the Corvallis company to develop a hand-held device based on the OSU team's work. Called the Ping Meter, it uses near-infrared light to monitor nitrogen and chlorophyll in leaves. Combined with the meter's GPS-based mapping capability and plant species databases, these indicators can empower growers in managing their crops, says Plotkin.

Ping Meter? The name plays on the idea that radar, sonar and other monitoring methods "ping" objects and return an echo that can be displayed and analyzed. And it honors work by OSU graduate Ding whose statistical analyses of near-infrared light experiments played an important part in making the meter possible. With a Patent Cooperation Treaty application in hand, OSU is completing a licensing agreement with the company.

Seedbed for Growth

If final patent protection is granted, the science and engineering behind the Ping Meter will add to the 181 OSU innovations that have been patented since 1980 in agriculture, wood science, engineering, chemistry, microbiology and veterinary medicine. Some have reached the marketplace, and others require additional research. But as a group, they represent a seedbed of potential products, a growing resource for established corporations and startup entrepreneurs like Plotkin. And new opportunities are emerging. Last fall, they included an environmentally friendly polymer invented by undergraduates working with chemical engineer David Hackleman and a disease-resistant Port Orford cedar rootstock developed by plant pathologist Everett Hansen (under development by Monrovia, the world's largest wholesale nursery).

Such innovative technologies will drive future economic development, says John Cassady, OSU vice president for research. Companies are increasingly looking to universities to provide the science behind new products. Moreover, state governments from Georgia to Oregon are pursuing economic development by investing in partnerships that bring top-notch experts together across the academic and corporate landscape.

Oregon has three such initiatives in nanoscience, sustainable technologies and drug discovery. All focus on translational research, the application of lab results to circumstances that are relevant to the marketplace.

"The states are seeing there's potential to drive their economies through universities," says Cassady. "You have to be proactive in trying to move through the translational stages to the point where it has an impact on the economy."

Pressure on states to attract jobs has been growing for decades, notes a recent report by the Pew Center for the States and the National Governors Association, but global competition is raising the stakes: "States must accelerate their efforts or risk becoming economic backwaters. Specifically, they must become places where new ideas are discovered, invented or given their first big break." (*Investing in Innovation*, 2007)

To generate more ideas that lead to products like non-toxic wood adhesives, disease-resistant crops and the Ping Meter, Cassady wants to expand collaboration between OSU, other universities and the private sector. He has created a university/industry partnership committee, which, with the help of pharmaceutical-executive-turned-consultant John MacDonald of Massachusetts, is surveying technology transfer officers and corporate executives about effective partnerships.

"Universities are starting more and more to build these clusters of innovation and be recognized on a global scale," says MacDonald. "At the same time, industry is seeing the relationship divide in such a way that the early discovery process is going to reside at the university, and the development and commercialization are going to evolve on the company side."

With a history of partnering through Cooperative Extension, agricultural experiment stations and other units, land-grant universities are in a strong position to foster such partnerships, he adds. "They need to be proactive in their relationships, develop clusters of innovation that are going to solve problems and meet needs, generate the return on investment that industry is looking for. Partnering has to become part of the DNA of OSU."

More Than Technology

Such relationships depend on discoveries that come to light through confidential "invention disclosures," a description of an idea or technology. Brian Wall, interim director of OSU's Office of Technology Transfer, says his office now receives 60 to 70 disclosures annually. Based on market analysis, patent potential and additional research by the inventor, Wall will typically apply for provisional patent protection on half of them.

It can take up to five years and cost $15,000 to $40,000 to secure a decision from the U.S. Patent and Trademark Office. Multiply the numbers, and risk for the patent applicant mounts. For universities that bet on multiple inventions, payback can come through license fees or an equity stake in just one blockbuster technology. In 2007, OSU received $2.5 million in licensing revenues and $100,000 in a sale of stock in Clear Shape Technologies, a Silicon Valley firm.

Nevertheless, Wall and Cassady stress that institutional finances are not the only, or even the most important, consideration. For them, graduates are OSU's most significant contribution to economic development. "Most universities realize that one of the most important things we produce for these companies is talent. It's not just about research and development and intellectual property. It's about students," says Cassady.

"Students may join companies that aren't based on OSU technologies," adds Wall, "but they got their education here. Or they join small companies and build them. Or they join Intel or HP down the road and build a whole new division."

So the strategy in the Office of Research is multi-pronged, supporting students with research grants and assisting faculty at each stage of the process. For entrepreneurs like Larry Plotkin, education and technology together represent a mother lode for Oregon's economic future.

– Nick Houtman

Learn more about OSU patented technologies and resources available to startup companies at *oregonstate.edu/research/technology*

Innovations to Market

New products stem from OSU research. Here are some examples in the pipeline and on the shelf.

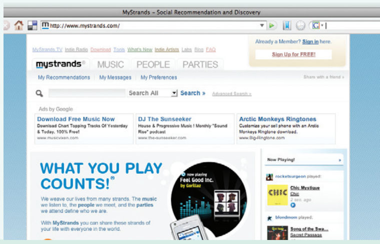
Agriculture

Tried Fizzy Fruit yet? Or the spicy hazelnut mix Oregon Dukkah? Scientists and entrepreneurs have developed these and other new products at the Food Innovation Center in Portland. Other OSU-inspired foods include surimi, oyster shooters, microbrew beers, Umatilla Russett potatoes, Shay apples, Cascade pears, and Clearfield, Stephens and SuperSoft wheat.

Forestry

New soy-based wood adhesives are replacing glues made with formaldehyde in the composite-wood industry. Researchers have also developed new value-added wood processing methods, nanocellulose membranes and pheromones for bark beetle control in Douglas-fir stands (see Page 17).

mystrands

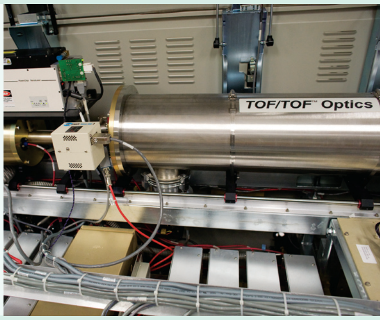


Engineering

Software tools (Smart Desktop, GoalDeBug and MyStrands) help office workers and consumers find what they need and become more efficient. Other technologies on the horizon: a portable kidney dialysis system, direct-drive wave energy buoys, transparent integrated circuits and biological and microchemical manufacturing processes.

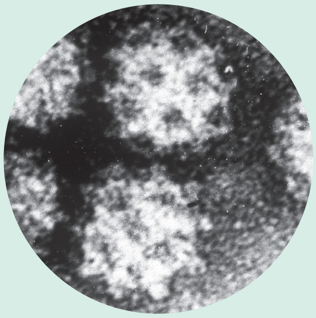
Microbiology

Basic research laid the groundwork for the development of an experimental smallpox drug by SIGA Technologies. Patents have been granted for methods to grow microorganisms, to detect bacterial pathogens and to thicken drink products and pharmaceuticals through bacterial polymers. OSU is now a world leader in the isolation and genome sequencing of microorganisms that affect global biogeochemical cycles.



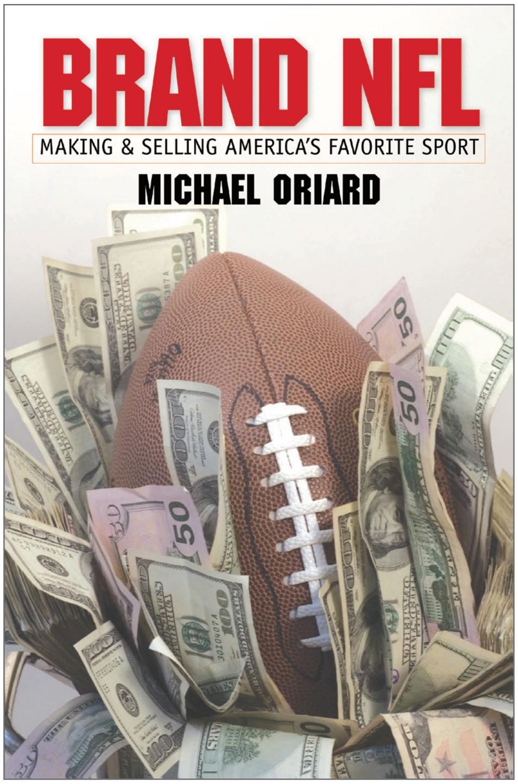
Chemistry and chemical engineering

An anti-cancer drug is in clinical trials, and enzymes for biomass ethanol are under investigation. Other developments include tandem time-of-flight mass spectrometry and novel optical materials.



Veterinary medicine

Cases of unexplained "stomach flu" have been traced to the Norwalk group of Caliciviruses. Another Calicivirus, which is zoonotic (transmissible from animals to humans), has been associated with liver damage and reproductive problems in horses, hogs, marine mammals and humans. OSU has a patent on methods for the detection, prevention and treatment of this Calicivirus group in humans.



"The president of a cable network feeding highly sexualized music videos to teenagers, and a woman as well, would head the NFL division that markets to fans of huge guys who grunt and sweat a lot."

Football as Product

By Michael Oriard
Distinguished Professor of American Literature and Culture

An excerpt from Brand NFL: Making and Selling America's Favorite Sport, *Michael Oriard. Copyright (c) 2007 by the University of North Carolina Press. Used by permission of the publisher. www.uncpress.unc.edu*

(Note: From 1970 to 1973, Michael Oriard played professional football with the Kansas City Chiefs. After completing his doctorate in American literature at Stanford, he joined the OSU English department in 1976.)

To a short list of milestones marking the creation of the new NFL — May 7, 1982, when Al Davis won the right to move his franchise; February 25, 1989, when Jerry Jones bought the Dallas Cowboys; May 6, 1993, when the owners and players finally signed a labor agreement — should be added July 12, 1994. On that day, the NFL announced that Sara Levinson, former copresident of MTV, had been hired as the new president of NFL Properties. This seemed like news of the you've-got-to-be-kidding sort. The president of a cable network feeding highly sexualized music videos to teenagers, and a woman as well, would head the NFL division that markets to fans of huge guys who grunt and sweat a lot. The significance of Levinson's hiring was perhaps mostly symbolic. MTV represented the cultural forces against which the NFL had held up as a bulwark since the 1960s. The NFL was also, at all levels, overwhelmingly a men's club. Hiring Levinson to market professional football represented a decision at the highest levels that NFL football was no longer your father's Sunday pastime.

Explanations followed. MTV and Levinson represented two potential audiences that the NFL coveted, young people and women. Her hiring, however, confirmed something more fundamental: that the NFL now openly regarded itself as a "brand" and pro football as a "product" to be marketed. . . .

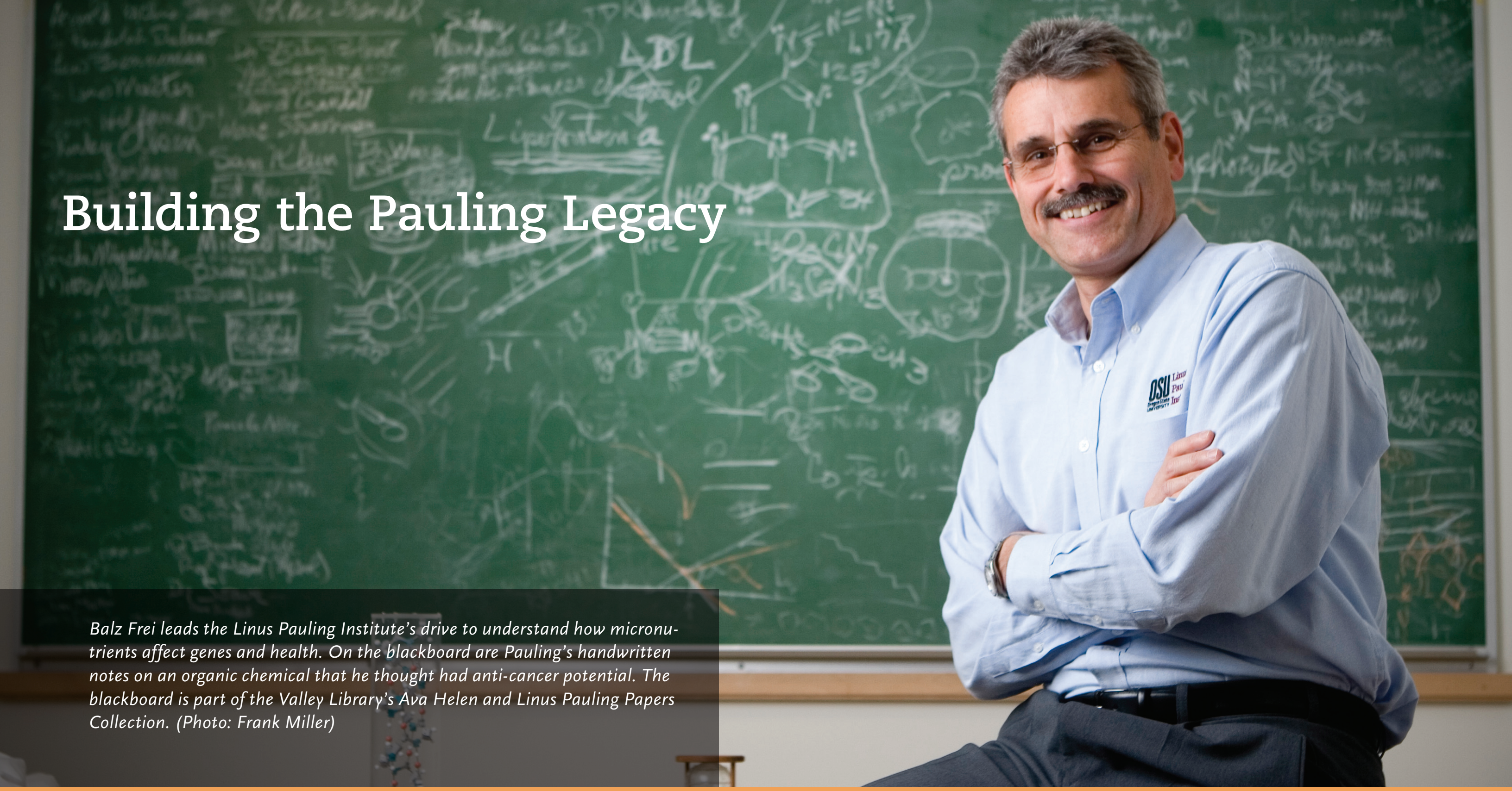
By 1993, the year before Levinson arrived, NFLP's gross revenues reached $2.5 billion, a five-fold increase since 1986. A marketing and promotions division sold corporate sponsorships, and a publishing division still produced the game programs sold in stadiums; but retail licensing, to some 350 manufacturers of 2,500 different items by 1991, generated the overwhelming bulk of revenues. . . .

The NFL's operating assumption, that football sold itself and could be used to sell other products, seemed to change when Levinson came in to promote NFL football itself more aggressively. Whether the hiring of Levinson, within months of a new labor agreement, new television contracts, and league expansion, was itself a tipping point or just a symbol of it, league officials in general and those at NFLP in particular began to talk more openly about NFL football as a "brand" in "the competitive business of sports and entertainment." The NFL now competed, one spokesman in 1995 explained, not just with the NBA, the National Hockey League and Major League Baseball, but also with "Batman movies, *Aladdin* and *Pocahontas*," the entire world of popular entertainment and leisure options. Owners and players took the same side here. As Gene Upshaw put it, NFL owners no longer competed for revenues against NFLPA [National Football League Players Association], but hand-in-hand with the NFLPA against "all the other entertainment choices out there: the movies, music, theater."

What the hiring of Levinson meant to the National Football League was the subject of a shrewd essay in *The New Yorker* by John Seabrook in 1997. As [former NFL Commissioner Paul] Tagliabue explained to Seabrook, ESPN and Fox had introduced a new "attitude" in sport broadcasting, one "more youthful" and "iconoclastic." In addition, polls showed that kids had become more interested in basketball and soccer than in football, and more and more mothers did not want their sons risking injuries in contact sports. The bottom line was that those running the NFL could no longer take football's powerful appeal for granted, and they feared losing an entire generation of lifetime football fans (and that generation once lost might spawn another, then another). Millions still lived and died with their favorite teams each Sunday, but those passionate fans were aging, and there were other millions coming up behind them to be wooed. As Seabrook put it, Tagliabue "needed someone who could make football attractive to a new generation without disgusting the middle-aged bratwurst-and-beer types who enjoy going to games with their faces painted in the colors of their teams." Reporters for *Business Week* used similar language when they saluted Levinson as "just what the NFL, that 75-year-old temple of testosterone, needs as it tries to score with a generation of channel surfers while holding on to its core Joe Sixpack crowd."

See a list of other books written by Michael Oriard at ***oregonstate.edu/cla/english/faculty/oriard***

Building the Pauling Legacy



Balz Frei leads the Linus Pauling Institute's drive to understand how micronutrients affect genes and health. On the blackboard are Pauling's handwritten notes on an organic chemical that he thought had anti-cancer potential. The blackboard is part of the Valley Library's Ava Helen and Linus Pauling Papers Collection. (Photo: Frank Miller)

Oregon native Linus Pauling had already won two Nobel prizes when he turned his genius to the chemical complexities of diet and health. Not content to rest on his laurels as a world-renowned chemist and international peace activist, Pauling plunged with characteristic ardor into the study of micronutrients, particularly vitamin C, in the late 1960s.

Some four decades later, Pauling's legacy is about to turn a corner in the field he pioneered. Under the leadership of biochemist Balz Frei, OSU's Linus Pauling Institute is poised to expand its prominence in nutrition science with the construction of a state-of-the-art research facility in Corvallis, where Pauling began his career. More than $31 million in private donations (including $20 million from the Wayne and Gladys Valley Foundation and over $10 million from Pat and Al Reser) have been matched by state bonds for the $62.5 million building, scheduled to break ground in 2008.

The new science center will include part of the OSU Department of Chemistry and allow LPI to grow not only in size but also in scope.

"Right now, we are investigating three major disease areas in our laboratories, all relating to the role of diet, micronutrients and lifestyle," says Frei, who holds the endowed Linus Pauling Institute Chair. "One is cancer chemoprevention, another is heart and metabolic diseases, and the third, our smallest, is healthy aging and neurodegenerative diseases. I'd like to expand our efforts in this third area."

Frei, a specialist in oxidative stress and atherosclerosis, envisions three new research positions that will build on the work of LPI's aging expert, Tory Hagen, holder of the Endowed Chair for Healthspan Research, who studies oxidative stress, lipoic acid and mitochondrial dysfunction in aging. The goal is to expand LPI's investigation of the impact of diet and lifestyle on the basic biological mechanisms of aging and on neurodegenerative diseases like Alzheimer's or Parkinson's disease.

"We want to understand how nutrients interact with genes, turning them on or off, and how we can affect these mechanisms through diet and lifestyle to improve health in the elderly," Frei says. "We also want to look at immunosenescence, the decline of the immune system as we age, and the role of nutrients and lifestyle in this process."

Aging was of keen interest to Pauling himself. In the 1950s, he began to study the biochemistry of mental illness. How, he wondered, did nutrition affect brain chemistry? Could an optimum intake of micronutrients improve mental and physical health and decrease risk of age-related diseases? Despite the controversy sparked in 1967 when he dubbed the budding study of micronutrients and human health "orthomolecular medicine," Pauling never backed down from his stance that micronutrients hold the key to fighting disease and fending off the worst ravages of old age.

OSU's new Linus Pauling Science Center will carry his vision into the 21st century.

To learn more about the Linus Pauling Institute, see ***lpi.oregonstate.edu***

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The 35-ton hydraulic crane he uses in his laboratory to hoist full-size girders lets OSU researcher Christopher Higgins study the strength and safety of America's bridges on an unprecedented scale. See "Fear and Loading," Page 3. (Photo: Karl Maasdam)

Wanted: Your opinion! Terra is conducting its first reader survey online. We'd love to hear from you by February 15. **oregonstate.edu/terra**

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