



tterra

A world of research & creativity at Oregon State University • Winter 2007

A Question of Survival

An Arctic culture faces tough odds in a changing climate

Across the Divide
Parting the waters

Small Miracles
Harnessing
nanotechnology

Aptitude for Aging
It's personal



t r a n s i t i o n s

Transitions can be painful.

Ask a salmon fisherman whose boat stayed at the dock most of the season, a millworker whose job has gone overseas or a parent whose children have left home. We know that stability is short-lived, that change is the rule. We adapt by learning new skills and pursuing other interests. Just as important, we orient ourselves by remembering where we've come from.

Over the past 40 years, the people of King Island have had a particularly difficult time. As long as anyone can remember, this Inupiat community in Alaska has depended on the walrus hunt. In the 1960s, after a forced relocation to the mainland, they turned their ancestral home into a seasonal hunting camp. Now their quarry is getting harder to reach, thanks to changing Bering Sea ice conditions, a consequence of a shifting climate. An OSU research team led by anthropologist Deanna Paniataaq

Kingston is working with them to preserve their past — and Kingston's.

The King Island story shows how culture is intertwined with environment and economy. Two other cases in point: water and aging. Work by OSU water specialist Aaron Wolf reveals the rules developed by traditional communities to share streams and wells. Water availability swings between drought and flood, but these cultures have adapted with a focus on fairness.

Aging across the life cycle — from youth to adult to elderly — is also changing. OSU professors Karen Hooker and Richard Settersten work at different ends of the spectrum, but their work shows how human development is sensitive to new circumstances — longer lifespans and complex economic demands. Such transitions can be difficult, but Hooker and Settersten are helping us to adapt.



On the Cover:

"Nuktaya, King Island," by Edward S. Curtis (1928), courtesy of the Northwestern University Library. Curtis, photographer and entrepreneur, described the King Island community in his 20-volume set, *The North American Indian*. In 1998, the Northwestern University Library began digitizing the entire collection, including 2,226 photogravure plates and 5,000 pages of text. It is online at curtis.library.northwestern.edu/



President
Edward Ray

Vice President for University Advancement
Luanne Lawrence

Vice President for Research
John Cassidy

Editor and Director of Research Communications
Nicolas Houtman

Research Writer
Lee Sherman

Photography
Claire Alix, Mary Dillard, Brian Duggan, Jim Folts, Matt Ganley, Peter Krupp, Karl Maasdam, Jeremiah Osborne-Gowey, Aaron Wolf

Design
Tina Chovanec, Art Director; Christopher Hunter, Designer

Illustration
Santiago Uceda, Christopher Hunter, Scott Laumann

OSU is Oregon's largest public research university with \$193 million in research expenditures in FY2006. 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.

Terra is published three times per year by University Advancement with support from the Oregon State University Foundation and printed with vegetable-based inks on paper with 50% recycled content.

Contact Nicolas Houtman:
nick.houtman@oregonstate.edu
416 Kerr Administration Building
Oregon State University
Corvallis, OR 97331
541.737.0783



Departments

- 14 STEWARDSHIP**
Managing Nature's Resources
Canola Fuels Debate, Research
- 15 EARTH**
Understanding the Planet
Scientists Witness Undersea Eruption
Genes of Autumn
- 20 INNOVATION**
Promoting Entrepreneurship and Invention
Know Thy Customer
Clear Shape Technologies
- 21 INQUIRY**
Exploring the Arts and Sciences
Reinventing High Schools
- 22 VITALITY**
Advancing the Life Sciences
Aptitude for Aging
Communication Breakdown

Also in this issue

- 24 Are We There Yet?**
The twisting road to adulthood
- 25 Pressure's On**
High-strength building products

Terra is on the Web at oregonstate.edu/terra

See photos from research trips to King Island, Alaska, and videos of an erupting underwater volcano.



Watch how OSU wood scientist Fred Kamke turns low-value poplar into high-strength wood in his lab.

Listen to a podcast with Michael Dalton and Molly Knott of OSU's College of Education to learn how some high schools are engaging students and communities in revitalizing education.

Features

2 The Ice Sages

For millennia the people of King Island have depended on the walrus hunt. But as Arctic ice recedes in response to a changing climate, hunters have to go further to reach their quarry. OSU anthropologist Deanna Paniataaq Kingston, whose mother grew up on the island, leads a team documenting the culture, language and natural history of her ancestral homeland. (Illustration: "Fishing for King Crab, Ukivok," by Rie Muñoz.)

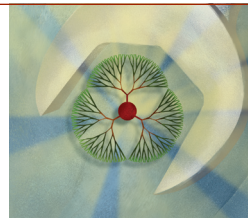
10 Across the Divide

Water binds communities, from villages to nations. Using traditional knowledge and modern conflict resolution, Aaron Wolf has assembled the tools to help manage international waters and promote peace.



16 Small Miracles

Nanotechnology is not just a pipe dream. It's on store shelves, in clothing and in our vehicles. OSU researchers and their partners are delving deeper into the molecular machinery that may underlie new 21st century products.



19 Medical Pioneer

Erin Rieke wants to be a doctor. So on her way, this senior from Tualatin, Oregon, is learning to culture breast cancer cells and make high-tech dendrimers, synthetic particles that can deliver drugs to target cells.



The Ice Sages

Walrus hunters and Western scientists study a changing Arctic

By Lee Sherman

After years of warm weather and poor ice in the Bering Strait, the winter of 2006 felt more like the winters of old. On a rocky island 40 miles off the Alaska coast, thick ice hemmed the shores well into June. For two Inupiat men who volunteered to help an OSU team conduct research there, the ancestral tug was too strong to fight. They suspended their work to join a walrus hunting party, heading out in an aluminum skiff toward the massive floes drifting northward.

“Walrus,” one King Islander says simply, “is very much part of our life.”

For centuries, the tusked pinnipeds were the mainstay of King Island. Their rich, fatty meat was a prized delicacy. Their skins were stitched for boats, parkas and mukluks. Their hides kept the winds from screaming through the people’s huts. Rope was fashioned from walrus rawhide. Tusks were carved as tools, or with decorative scrimshaw for trade on the mainland. Even the intestinal lining, lightweight and waterproof, was sewn into raingear. Every part of the honored animal was used.

“King Island,” 1974, by Rie Muñoz, reprinted with permission of the Rie Muñoz Gallery, Juneau, Alaska. Muñoz has a personal connection to OSU. When she taught on King Island in 1951, one of her young students was Olga Muktoyuk, the mother of OSU anthropologist Deanna Paniataaq Kingston. More than 200 art galleries in the West feature Muñoz’s colorful watercolors.



ESKIMO WOMEN FISHING FOR TOM COD AND KING CRAB ON THE NEW HUNTERS NOW LIVE IN NOME. THE HUNTERS RETO



OSU anthropologist Deanna Paniataaq Kingston — a descendent of King Island — is leading a study of her ancestral Inupiat culture with funding from the National Science Foundation and assistance from 30 native elders. (Photo: Peter Krupp)

One hunter, when asked about the significance of walrus to King Islanders, answered, “You can’t live without it.”

Social structure, values and spirituality also centered on the great ice-borne beasts of the Arctic. Skilled hunter Vince Pikonganna reports that the walrus hunt “binds people together.” Bonds of kinship and friendship, he says, are “re-glued” as the community works in concert for mutual survival. “Sharing, sharing is a big thing among the natives, sharing,” Pikonganna stresses.

But the ancestral connection to the sea and its creatures is growing fainter each generation — not only for King Islanders but for all the indigenous peoples of the Arctic region, the Inupiaq, Yupik and Alutiiq (peoples known collectively as Eskimo) and the Athabaskan Indians of Alaska’s interior. That’s because they are, to borrow a phrase from the First Alaskans Institute, “at the epicenter of global warming.” As temperatures rise and ice recedes, marine animals migrate northward or spiral into decline, seas surge higher and storms rage more fiercely. The *Anchorage Daily News* reported in April that 184 coastal and river communities in Alaska are already feeling the effects of increasing erosion, melting permafrost and collapsing fisheries.

“At King Island we lived by the weather.”

— Paul Tiulana, author
A Place for Winter, 1987

Scientists are in agreement that northern populations deeply reliant on nature are on the front lines of climate change, precisely because their sustenance and their culture are embedded in — indeed, are indistinguishable from — the natural world. The very reliance on nature that makes indigenous people vulnerable to shifting climates, however, also makes them repositories of centuries-old knowledge. Western scientists are beginning to actively seek that knowledge to help them puzzle out the intricate ecological systems of the Arctic.

One of those Western scientists, OSU anthropologist Deanna Paniataaq Kingston, is leading an effort to preserve the ecological knowledge of King Islanders. With \$540,000 in support from the National Science Foundation (NSF), she and an interdisciplinary team of researchers are working with Inupiat elders to catalog the place names, edible plants, birds and dialect of the island. And,

as the scientists are discovering, King Islanders' intricate knowledge of weather, currents and ice formations wraps around everything. The OSU team believes that critical clues to Arctic climate systems reside in the community's collective understanding of its world.

On a misty August morning in 2004, Kingston — white-knuckled, sweating in her emergency immersion suit — was about to touch down on her ancestral homeland. She held her breath as the chopper pilot circled the fog-shrouded island, looking for a clearing. A descendant of the storied walrus hunters of King Island, the OSU anthropologist embodied two distinct worldviews as she took her first step onto that rocky outcropping in the Bering Sea: Western science and traditional knowledge.

Raised mostly in the Lower 48, Kingston is a product of mainstream America. Her Inupiaq mother rarely talked about her early childhood on the island, so Kingston gathered what fragments of King Island culture she could from her uncles Gabe, Alex and Edward Muktoyuk and her Aunt Margaret. But as a graduate student at OSU and then at the University of Alaska Fairbanks, she dove headlong into her lost heritage. She researched traditional kinship patterns. She documented dances that celebrated hunting success. She interned at the Smithsonian's Arctic Studies Center, studying artifacts and photos. She worked on a film collection of last-century King Island life, originally housed

at Santa Clara University and now residing at the Human Studies Film Archives at the National Museum of Natural History.

She saw the early 20th-century sepia tones of frontier photographer Edward S. Curtis and the black-and-white photographs of "glacier priest" Bernard Hubbard, capturing hundreds of images of life from the time when winters were colder and longer. Those images — of faces framed by fur-trimmed parkas, of walrus-skin huts secured to the near-vertical cliff by driftwood stilts, of hunting and dancing and boat building, of mothers carrying babies bundled snugly on their backs — were, for Kingston, a haunting reminder of what had already been lost.

In 2003, the NSF grant gave Kingston the chance to meld the two worldviews that not only define her as a person, but that also form a more complete understanding of Arctic ecology. The four-year study reflects a growing movement in anthropological and ecological studies to draw upon the wisdom of ages. Traditional ecological knowledge — TEK — has gained stature recently among natural resource managers, biologists and social scientists as an important complement to Western scientific knowledge about plants, animals and the environment.

The international Arctic Climate Impact Assessment, for instance, drew heavily on indigenous knowledge for its comprehensive (and dire) report, *Impact of a Warming Arctic*, published by Cambridge University Press in 2004. "As the indigenous peoples perceive it," writes author Susan Joy Hassol, "the Arctic is becoming an environment at risk in the sense that the sea ice is less stable, unusual weather patterns are occurring, vegetation cover is changing, and particular animals are no longer found in traditional hunting areas during specific seasons. Local landscapes, seascapes and icescapes are becoming unfamiliar, making people feel like strangers in their own land."

Zeroing in on one of the hundreds of indigenous groups in the Arctic Circle, which embraces the coasts of Canada,

In the Bering Strait 40 miles off Alaska's mainland, King Island provided rich sustenance for generations of Inupiat walrus hunters, who braved the frigid seas in wood-and-skin kayaks and umiaks (large canoes) known throughout the region for their seaworthiness. (Map illustration: Christopher Hunter)



The Arctic in Transition

OSU scientists across an array of disciplines are in the vanguard of international research on Arctic warming. Here is a sampling of investigations under way in the colleges of Atmospheric and Oceanic Sciences, Science and Agricultural Sciences.



Kelly Falkner (oceanography)

Arctic Ocean variability: By tracing water chemistry from the North Pole to the Canadian Archipelago and Nares Strait, Kelly Falkner is learning how changes in rivers and ocean circulation are related to climate effects.



Ed Brook (geosciences)

Ice core studies: In ice cores from Greenland and Antarctica, Ed Brook is finding historical records of millennial-scale abrupt climate change. He is also analyzing ancient air from old ice outcroppings for clues to climate change mechanisms in recent geologic time.

Right: Clinging to the near-vertical cliffs of King Island is the village of Ugiuvak. Built on driftwood stilts, the 18th-century huts had walls of walrus skin until milled lumber became available. (Photo: Claire Alix)

Below: When famed frontier photographer Edward S. Curtis made this photogravure in 1928, the Inupiat people of King Island were known to Westerners as the "northern seacliff-dwelling Eskimo." (Edward S. Curtis image courtesy of the Northwestern University Library)



**Jesse Ford
(fisheries and wildlife)**

Arctic contaminants: By studying the pan-Arctic distribution of contaminants in fish and vegetation, Jesse Ford is trying to understand the distribution and drivers of Arctic "hot spots" of heavy metals and persistent organic pollutants.



**Alan Mix
(oceanography)**

Alaska fjord survey: By surveying seafloor surfaces and recovering sediment cores from Alaska fjords and the Gulf of Alaska, Alan Mix is compiling data on past climate variability that extends the historical record.



**Peter Clark
(geosciences)**

Dating glacial moraines: Using new isotopic dating techniques on glacial moraines in Labrador, Peter Clark is gathering clues to the timing and dynamics of the last period of deglaciation — and seeking processes of change during a warming climate.



In the summer of 2005, King Island elders who volunteered to assist OSU researchers in a three-year study of their ancestral homeland donned emergency immersion suits for the helicopter flight from the mainland across the Bering Sea. From left to right are Edward Muktoyuk (Deanna Kingston's eldest maternal uncle), Cecilia Muktoyuk (Edward's wife), Agatha "Tiiguk" Ford, Bertha Herzner, Olga Kingston (Kingston's mother) and Pat Sagoonick. (Photo: Jeremiah Osborne-Gowey)

Russia, Scandinavia, Greenland and Iceland, OSU's project "seeks to understand King Island TEK as a complete system of knowledge," Kingston says. "We hope to document not only King Islander knowledge of their physical environment, but also how the physical environment is incorporated into their belief system, values and rules for behavior."

"The ice never sleeps." — Paul Tiulana

Since the islanders relocated to the mainland a half-century ago, the old ways have become harder and harder to keep. For Kingston and her colleagues, there is a sense of urgency to documenting a culture that began to disintegrate in 1959 when the Bureau of Indian Affairs closed its school and threatened to arrest islanders who failed to send their children to mainland schools. A few families at a time, the community drifted to Nome. By 1966, the island was used

only as a seasonal hunting camp. Just 30 or 40 of the men still hunt, now using aluminum motorboats instead of their once-famed skin umiaks. The National Trust for Historic Preservation recently named King Island one of the 11 most endangered historical sites in the U.S.

So when one of the elders of King Island, a woman named Marie Saclamana, asked Kingston to help save this ancient knowledge for yet another generation, Kingston pulled together a team of archaeologists and biologists, as well as a linguist specializing in Inupiaq. And she assembled a group of native King Islanders willing to revisit their childhood home — a place whose Inupiaq name, *Ugiuvak* (also spelled *Ukivok*), means "place for winter."

These King Island elders have joined Kingston and her colleagues on their once-familiar island for the past two summers, foraging the boggy tundra atop the island for specimens of the greens, roots and berries that balanced their childhood diet of walrus, bearded seal and the occasional polar bear. OSU biologist Jesse Ford, one of Kingston's co-principal investigators, is collaborating



**Anne Nolin
(geosciences)**

Ice-sheet mapping: Sophisticated new sensing techniques devised by Anne Nolin have led to more accurate mapping of ice-sheet albedo (reflectivity), ice-sheet roughness, and snow-covered locations with vegetation cover — key factors in monitoring climate change.



**Staci Simonich
(environmental toxicology/chemistry)**

High-elevation contaminants: By tracing airborne contaminants through high-elevation National Park ecosystems, Staci Simonich is shedding light on how pollutants move from atmosphere to snow, vegetation, lake water, fish and sediment.



**Andrew Meigs
(geosciences)**

Glacial erosion rates: Andrew Meigs' studies of erosion and mountain-range growth in Alaska suggest that erosion rates are linked to climate change and glaciation.

with the elders to identify and classify the subsistence plant species in both English and Inupiaq.

OSU ornithologist Kim Nelson is doing the same for King Island's birdlife — the crested auklets, murres and other species that were prized not only for meat but also for eggs, collected from the craggy cliffs as the waves crashed below. Although much more data is needed, Nelson saw possible portents of changing distribution: a hermit thrush usually seen on the Seward Peninsula many miles to the south and a hawk owl, never before seen on the island. It's too soon to tell whether these sightings were anomalies or signs of Arctic warming. "Were they pushed north on a storm?" Nelson posits. "Were they lost? Or are they expanding their range in response to climate change?" Only future population surveys will tell for sure.

The theme that surfaces again and again in the King Islanders' accounts is weather. Even in an earlier study of walrus hunters, Kingston, Ford and others found that although their knowledge of walrus biology was extensive, it was secondary to their knowledge of winds, currents, storms and, above all, ice. "Really, walrus hunting is only partially about the walrus," says Ford. "It's everything about the ice, the winds and the weather, about which there is a very detailed understanding."

To survive in the Bering Sea is to know ice, intimately, in all its forms: the shore ice ("landfast ice") that freezes outward, anchored to the land. The pack ice ("sea ice") that drifts by, bearing seals and walruses and polar bears. The channels through the ice ("leads") that provide avenues for kayaks and umiaks. The open water ("polynyas") encircled by pack ice where marine mammals come up to breathe.

Over and over, the elders say the ice is changing. It forms later in the fall and melts earlier in the spring. It's thinner, less likely to hold the weight of a walrus — or a man. "We hardly catch any walrus now because the ice is too thin," one hunter reports. Says another, Joe Kunnuk Sr.: "Sometimes, I think to myself I don't know if I'm going to see walrus again because of the weather and ice conditions."

This ice decline, long known to the King Islanders, has only lately captured the attention of the American public. Typically, Americans' notions of the Arctic have been limited to the historic and heroic (the expeditions of Robert

Peary and Richard Byrd) or have tended toward the romantic, quaint and exotic (igloos and the Iditarod, the aurora borealis and "land of the midnight sun"). But a sober new awareness of the Arctic impacts on global warming is taking hold. So, as climate science begins to make headlines in hometown dailies, terms such as "albedo" (ice's reflective whiteness, a shield against heat absorption), "under-ice algae," "polar amplification," and "ice-edge systems" are seeping into popular parlance.

Now that the stakes of unchecked Arctic warming are crystallizing in the collective psyche, it is increasingly important, Ford says, for willing bearers of Western and indigenous knowledge, despite their vastly disparate paradigms and epistemologies, to work toward a more complete understanding of what is happening, and perhaps come up with novel ways to address emerging issues. "We're under the gun," she says. "Ecosystems are collapsing and cultures are struggling, left, right and center — cultures that are based on those ecosystems."

Jessica Cardinal, who interviewed walrus hunters along with Kingston and Ford as a graduate student in OSU's Marine Resources Management program, notes, "Western science and knowledge, while creative at predicting global environmental change, is limited in its understanding of how climate will change processes and events at the local level." Now an academic adviser for the College of Science and coordinator for the Native Americans in Science, Engineering and Natural Resources program, Cardinal explains the unique contributions of indigenous knowledge this way: "The capacity of local peoples can add site-specific information, bring attention to signs or indicators, and highlight relational information."



King Island culture centered on Pacific walruses that traveled north on ice floes each spring, providing hunters with food, warm skins, ivory and even raingear sewn from the waterproof intestines of the great tusked mammals. (Photo: National Oceanic and Atmospheric Administration)



David Graham
(oceanography)

Arctic Ocean geochemistry: On expeditions to map the seafloor and collect water samples in the high Arctic and North Pole, David Graham has discovered important clues to the tectonic history of the region.



Nick Piasias
(oceanography)

Regional climate change: By examining historical climate shifts with advanced statistical methods, Nick Piasias is trying to understand links between climate variability in the low-latitude oceans and effects seen in the Arctic.



Fred Prah
(oceanography)

Organic biomarkers: By decoding the composition of organic molecules in marine sediments off Alaska, Fred Prah is tracing the inputs of carbon from land to the ocean and developing organic tracers of climate change.



Elder women — Agnes Mayac, foreground, and Leona Mayac — grew up on King Island decades ago and returned with OSU researchers in 2005 to gather specimens of the plants that once supplemented their diet of walrus, seal and seabirds. (Photo: Mary Dillard)

One big drawback to Western Arctic research, for instance, is its small window in the annual calendar. “Scientists tend to go to the Arctic only in the summer, so they don’t have much of a research base on winter conditions,” Kingston notes. “Indigenous people can help them understand these infinitely complex ecosystems not only in July and August, but all year-round.”

Other coastal communities in Alaska are looking at the King Island experience as they face environmental pressures to move inland. The hunters and reindeer herders of Shishmaref, for instance, are resisting government efforts to re-

locate them to the mainland towns of Nome and Kotzebue from the rapidly eroding Seward Peninsula. What they have witnessed among dislocated King Islanders is the profound rending of a culture that has lost its center, its tether to the Earth. A 2005 study by the University of Alaska Fairbanks for the U.S. Army Corps of Engineers, to which Kingston contributed, concluded that “historical case studies show that this scenario of ‘forced relocation’ would have dramatically negative cultural, economic, health and social impacts on the community of Shishmaref.”



Andreas Schmittner (oceanography)

Modeling ocean currents and biology: Using advanced computer models of the ocean and atmosphere, coupled to chemical and biological effects, Andreas Schmittner is examining global impacts of melting Arctic ice and greenhouse warming of the polar oceans.



Joseph Stoner (oceanography)

Paleomagnetism: Measuring the magnetism preserved in Arctic marine and lake sediments, Joseph Stoner has turned up evidence of rapid shifts in the Earth’s magnetic field.



Marta Torres (oceanography)

Clam shells and climate change: By measuring the isotopic chemistry of long-lived clam shells, Marta Torres is documenting long-term changes in Arctic Ocean salinity related to climate.

In the Bering Strait, one of the most productive ecosystems on the planet, King Islanders lived sustainably on their small volcanic island for at least a millennium. In the first-ever archaeological study there, the OSU team has found remnants of a prehistoric village. Archaeologist Matt Ganley of the Bering Straits Foundation, one of the principal investigators on the OSU team, discovered evidence of four or five stone houses clustered high above sea level. A partial excavation turned up pottery shards, charcoal and sea mammal bones. Radiocarbon tests dated the site at about 900 years old.

“In the Native way, everything is given by nature.”

— Paul Tiulana

“Islands in the Bering Sea,” says Ganley, “are known to have a history of occupation spanning 2,000 to 3,000 years.”

Over those millennia, a unique dialect of the Inupiaq language arose on King Island. Today, only about 100 native speakers remain. Lawrence Kaplan, the linguist work-



The boggy tundra atop the island supports many colorful species of wildflowers. This one, known in English as “pink plume” (*Polygonum bistorta*), is called qiblaziraat in Inupiat. (Photo: Mary Dillard)

ing with the OSU research team, is compiling a dictionary to preserve the dialect — and the knowledge it encodes. “Language is closely tied to culture,” says Kaplan, who directs the Native Language Center at the University of Alaska Fairbanks. “If a language isn’t used, cultural subtleties that are instantiated within the language can get lost.”

Nowhere are these linguistic subtleties more pronounced, he says, than in King Islanders’ expression of weather phenomena. While English often uses “circumlocutions” — roundabout ways — to talk about weather, the islanders have a very direct and specific vocabulary to pinpoint precise details that can mean feast or famine, life or death.

So from the root word for “ice,” *sigu* (also a verb meaning “when water freezes over”) are derived words to distinguish the strength of the ice relative to a hunter’s weight: *siguaq* means “a thin layer of new ice not strong enough to walk on,” while *siguliaq* means “young ice that is a few inches thicker, now possible to walk on.” Another unique term captures a traditional signal among walrus hunters: the verb stem *silik-*, meaning “to jump sideways on the ice,” which alerts fellow hunters of a walrus kill from a distance. *Siliktuaq*, then, means “he’s jumping sideways on the ice because a walrus has been killed.”

Kingston’s sense of urgency for the preservation of this unique culture was refueled recently when she ran across a report from the Woods Hole Oceanographic Institution. Nine baby walrus had been sighted far from shore in the Arctic Sea in the summer of 2004, swimming alone and barking plaintively at a passing research ship. Scientists aboard speculated that, in the absence of ice in the warmest water ever recorded there, walrus mothers had been forced to abandon their two-month old calves while they foraged for food in shallower waters.

For a dwindling band of walrus hunters, and for the anthropologist who studies and loves them, those plaintive barks echo mournfully. **terra**

To read a diary of the King Island 2005 field season and learn about the research team, see oregonstate.edu/clanthropology/staff/kingston/kingisland/



Timothy Boyd (oceanography)

Arctic Ocean monitoring: Collecting data on variations in circulation, heat and salt content — both historical and contemporary — Timothy Boyd has documented significant changes under way in the Arctic.



Evelyn Sherr, Barry Sherr and Yvette Spitz (oceanography)

Subsistence whaling: Evelyn Sherr, Barry Sherr and Yvette Spitz are investigating native communities’ resilience to climate variability. Their research focuses on interactions among atmosphere, sea ice, ocean, bowhead whales and subsistence whaling.

Across

THE

Divide

Parting the waters **By Nick Houtman**



In small Moroccan villages, tea and food accompany discussion. The topic here was water use. OSU water specialist Aaron Wolf (second from left) interviewed Hammou Magdoul (left), a farmer in Ameskar el-Fouqani, with help from his interpreter, Mohamed Zaki (right). (Photo courtesy of Aaron Wolf)

In the summer of 1997, Aaron Wolf and a Berber guide trekked up narrow mountain paths to a village high in the Atlas Mountains of Morocco. Despite the steep terrain, they walked lightly. A donkey carried their gear. As they moved toward snowcapped peaks, they crossed one dry, rocky ridge after another. It took four days for them to reach the M'Goun Valley, elevation 7,000 feet. Their destination was two villages: Ameskar el-Fouqani (upper) and Ameskar al-Tahtani (lower), two communities of mud and stone buildings set among irrigated hillside terraces.

The small spring-fed stream that flows through the villages is vital to the hundred or so families who live here. It serves their homes, powers a grain mill and waters crops and gardens. There is just enough water to meet their needs, but people have arranged to share the stream, doing in a microcosm what nations that divide rivers, lakes and groundwater aquifers do on a grand scale. It was a desire to learn about how a village manages competing demands — through rules that have ancient origins, predating 20th-century European colonization and the rise of an independent Moroccan government — that brought Wolf to this part of the world.

Arid communities with strong links to the past have useful lessons for a thirsty planet, believes Wolf, a water resources specialist and professor in the OSU Department of Geosciences. Traditional arrangements hold practical advice for countries with growing populations and increasing development pressures.

Funded by a grant from the U.S. Institute of Peace, Wolf's visits to the Berber villages and later to the Bedouin camps of Israel's Negev Desert documented rules that have worked successfully for centuries. For example, arrangements to share water are often based on time instead of amount. (In one case, families set their irrigation schedules according to when a mountain shadow crosses a stream.) This principle equitably distributes the risk of low-flow conditions during drought years. More typical throughout the world, including the United States, is allocation by volume, which allows some water users to have priority, regardless of how much is available from year to year. In case of drought, other users must do with less or go without.

In Berber communities, water irrigation intakes may be built with stones but not with concrete, guaranteeing a flow of water to downstream users. Following Islamic law, people in both societies do not sell water. Access for drinking is a fundamental right, although making use of canals, pipes and other infrastructure may carry a price tag.

When disagreements occur, they are brought before a locally appointed judge. Enforcement can be swift, Wolf recalls being told. Asked about how long one party to a dispute had to agree to a judge's decision, the judge replied by wetting his finger and holding it in the wind. "He said that if there was not agreement by the time his finger was dry, he would see to it that the man's house would be burned to the ground," Wolf says.



Politics and Databases

Wolf has built a career around assembling global water-related information and expertise, watershed by watershed. In his Ph.D. work at the University of Wisconsin–Madison, he focused on the Jordan River Basin in the Middle East, applying the theory of alternative dispute resolution to create a framework for decision-making. Water, he says, may be the single most important focus for continuing dialogue among Israelis, Palestinians, Jordanians and other groups.

“If you just talk about the politics, you end up banging your head against the wall. There is no way to move. Every word has 5,000 years of meaning,” says Wolf. “But if you think about the things that are related to this (water), you can find other ways to talk. . . . In my dissertation I set out to capture how water had played a role in the Arab-Israeli conflict over time. And found much to my surprise, because it wasn’t in the literature, there is a rich, rich history of cooperation and dialogue.”

Despite the breakdown of the peace process, he says, multilateral discussions about water continue to this day. The issue is one of personal interest to Wolf who, as a dual Israeli–U.S. citizen, was drafted and served as a paratrooper in the Israeli Defense Forces from 1986 to 1988. That experience, described in his book, *A Purity of Arms*, instilled in him a deep desire for finding ways to resolve conflict through peaceful means.

In addition to the Jordan, he has worked with organizations to improve management on the Columbia River

From this spot in the Bougmez Valley, it took three days for Aaron Wolf and his guide to cross the Atlas Mountains to meet with farmers and other residents of Berber villages. Wolf spent two weeks learning about the rules they have developed to share scarce water supplies. (Photo: Aaron Wolf)

in the Pacific Northwest, the Salween in Southeast Asia and southern Africa’s Okavango, the “jewel of the Kalahari.” Around the world, the stakes couldn’t be higher. Water development projects are key to social and economic progress, affecting agriculture, energy production, social relations and public health. Inadequate investment already has a staggering cost. The United Nations estimates that more than 1 billion people lack access to clean drinking water and that up to 5 million people, mostly children, die annually of water-related diseases. Some observers have suggested that water wars will haunt the future. “Water supplies are falling while the demand is dramatically growing,” warned Koichiro Matsuura, director general of UNESCO, in 2005.

While Wolf sees access to clean water as a formidable unmet challenge, he disagrees that water disputes will inevitably escalate into wars. It’s not that tension and conflict are absent from water management, he says. Rather, research by him and his students has found that cooperation over water — the kind of traditions exhibited by the Berbers and the Bedouins — is far more common than violence. In scouring historical records and cataloging modern decisions, they have found reference to only one “water war,” which occurred in the Tigris-Euphrates basin about 4,500 years ago. In the last 50 years, nations have



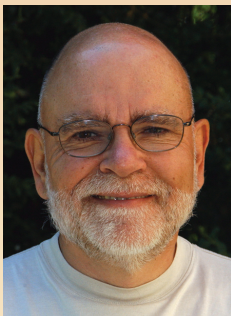
Western Water: from Dispute to Agreement

Water in the West has long been a trigger for disputes. Witness Colorado River diversions in California and Arizona and struggles in Oregon's Klamath Basin. But cooperation is still the

rule, according to research by master's student Kristel Fesler and a team of OSU students in the Department of Geosciences.

In a project funded by the federal Bureau of Reclamation, they have found that water-related events (newspaper reports) in the Colorado and Rio Grande basins more often reflect cooperation than conflict. In earlier research in Oregon, Fesler found that 65 percent of 384 water-related events between 1990 and 2004 were cooperative or neutral.

The strongest common thread among those involving conflict is change in government policy such as new regulations. The lesson: Agencies should foster productive, ongoing relationships with stakeholders and anticipate reactions to new regulations. A native of Minneapolis, Minnesota, Fesler worked with OSU professors Julia Jones and Aaron Wolf.



Water Research for Oregon

Umatilla Basin groundwater, Upper Klamath Lake wetlands, Willamette River flow requirements, water quality in the Deschutes River Basin — these are some of the subjects under

study in OSU's Institute for Water and Watersheds (IWW).

Under the leadership of Director Michael E. Campana, the IWW coordinates water-related teaching and research and applies OSU expertise to the water resources needs of Oregon citizens. More than 80 faculty members in six OSU colleges conduct water-related research, supported by more than \$11 million in annual grant funding.

Campana is past chair of the 10,000-member Association of Ground Water Scientists and Engineers. More online at water.oregonstate.edu.

signed 400 water-related treaties while 37 disputes involved violence, 27 of those between Israel and its neighbors.

In fact, their research suggests that, far from being an inducement to war, water management can be a pathway to peace. Cooperation over some of the world's largest rivers — the Nile, the Mekong, the Indus — has succeeded in the face of ongoing hostilities and contributed to productive relationships that make violence less likely.

Building the basis for those relationships, however, is hard work. Wolf and his colleagues have made a start. At OSU, where he is affiliated with the Institute of Water and Watersheds (IWW), Wolf spearheaded creation of the Transboundary Freshwater Dispute Database (www.transboundarywaters.orst.edu), an online library of agreements, case studies and events around the world. It includes maps showing the physical, social and economic circumstances that guide water-related decisions in Asia, Africa, Europe, and North and South America. OSU faculty members in the Northwest Alliance for Computational Science and Engineering (www.nacse.org) built the digital engine that drives the database.

To people struggling with water-related disputes, the database provides invaluable tools. "No matter where you work, people always think they are the only ones facing these issues. Water pollution, upstream/downstream relations, water rights. They're so relieved just to hear that other people have tackled them," Wolf says.

"There's no blueprint for solving conflicts from one basin to another. There are best practices. We've done a pretty good job of assembling them. And there are lessons — trends — where basins evolve over time through stages."

To help people apply those lessons and develop their own practices, Wolf helps to lead a group known as the Universities Partnership for Transboundary Waters. Currently, it includes experts from 14 universities on five continents. "People are grappling with these issues all over, and I want to see continued interaction between Oregon and the rest of the world. We have a lot to teach, and we've got some stuff to learn. I think it's useful to foster a sense of community around this," Wolf adds.

A recent example of such community-building endeavors focused on Africa. Together with colleagues at the African Water Issues Research Unit at the University of Pretoria in South Africa, Wolf produced an assessment of hydrologic risks and institutional abilities to address them in the continent's 63 international river basins. The



United Nations Environment Programme published their report in 2005, the first of five such continental-scale analyses.

That report has given a boost to people working on water resources management, says co-author Anthony Turton of the University of Pretoria. He credits Wolf with shifting the world's attention from water as a source of conflict to one of cooperation, with particular relevance for Africa. "I am grateful that he (Wolf) gave Africa a voice," says Turton. "His project allowed us to speak on behalf of Africa and present some facts with which to counter the prevailing 'Afropessimism.' For that, many Africans are grateful."

“Hydropolitical Resilience”

Key to the ability of countries to cooperate over water problems is a concept that is central to research by Wolf and his colleagues — “hydropolitical resilience.” The term refers to the expertise and resources that organizations need to adapt to changing environmental and social conditions. Countries need both the technical know-how — engineers, scientists, experts in public health and natural resources policy — and ways to integrate the views of people whose lives are at stake — farmers, fishermen and business people. Among these parties, skilled facilitators play a crucial role by guiding negotiations that can be contentious.

To meet these needs, Wolf and his colleagues are building on OSU's legacy of expertise in water science and engineering. The Water Resources graduate program offers students science, engineering and policy tracks. And a new program in Water Conflict Management and Transformation includes a graduate-level professional certificate for people to be trained in the principles and practices of conflict resolution.

“When you ask people in the water field what skills they wish they had more of, (they point to) how you dialogue, how you listen, how you identify common interests. Technical people are very good in many places, but they need people who can run these processes more efficiently,” says Wolf. “I see us being a training ground for anyone working in water.”

He also sees Oregon's water management experience as a model for others. “Our watershed councils are doing cutting-edge work in terms of local management and local participation. Power really is vested in the local community.” With funds from the U.S. Geological Survey and IWW, Wolf and OSU sociologist Denise Lach are



Stream water serves at least three purposes in the Berber village of Ameskar al-Tahtani. It powers a mill, carries away waste and fertilizes farm fields. “These people have been dealing with water conflicts for thousands of years,” says Aaron Wolf. “There may be lessons for the international community.” (Photo: Aaron Wolf)

documenting the successes of Oregon's local councils in resolving conflicts.

Respecting local knowledge and values can make all the difference, he adds, in the midst of a competition for resources. “You see it a lot in native systems. There's a balance of equity and honor. In a Bedouin land court, I heard a judge tell someone (who won a case), ‘You're right, but he (his opponent) still needs a livelihood for his family. Can we think of a way to make sure he still has his minimum needs taken care of?’”

Water management, Wolf and his colleagues stress, is conflict management. **terra**

To learn more about tools for international water management, see www.transboundarywaters.orst.edu/



— National Boundary

— Disputed Nation Boundary

JORDAN

JORDAN RIVER

WEST BANK

DEAD SEA



"Canola flowers will attract every bee from miles around," says OSU researcher Brian Duggan, who is studying the commercial potential of several canola varieties in Central Oregon. Canola's power to draw bees from other crops, such as carrots and onions, is just one of many canola-related issues worrying Oregon farmers. (Photo: Brian Duggan)

Canola Fuels Debate, Research

In the past couple of decades, canola has catapulted from obscurity to celebrity. The oilseed made its commercial debut in margarines and cooking oils, edging out more saturated-fat-laden competitors. Now it's gaining stature as the ideal oil for yet another consumer product: biodiesel.

But canola's rising profile has not come without controversy. A type of rapeseed bred in Canada (hence the name, "Canada" plus "oil"), canola has raised a number of agricultural concerns in Oregon, ranging from "rogue pollen" and "seed scatter" in the Willamette Valley to broader questions about its economic viability for Northwest farmers.

The science and economics of canola have the full attention of researchers in OSU's College of Agricultural Sciences, Agricultural Experiment Station and Extension. "We're providing research results to

officials at the Oregon Department of Agriculture (ODA) to help the agency refine its understanding of the risks and benefits of growing canola," says Russell Karow, chair of the Department of Crop and Soil Science.

Of immediate concern are the risks to the nationally and internationally important and lucrative vegetable and seed-stock businesses in the Willamette Valley. As a species of "brassica" that falls into the same genus as cabbage, broccoli and cauliflower, canola could potentially cross-pollinate or cause harm in other ways to these crops. Genetically modified canola has raised another alarm for growers who export to countries that ban genetically modified organisms (GMOs).

To prevent harmful cross-pollination or seed contamination, the ODA has set up canola-free buffer zones in traditional specialty-seed growing areas of the state.

"We're providing research results to officials at the Oregon Department of Agriculture to help the agency refine its understanding of the risks and benefits of growing canola."

**Russell Karow, Chair
Department of Crop
and Soil Science**

But entrepreneurs, eyeing new markets for canola, are pressuring the agency to loosen those restrictions. New canola planting in the valley is on hold, pending data from OSU and further public discussion.

The ag college's research isn't, however, limited to seed and pollen issues. Lab studies in Corvallis and field trials across the state are investigating a range of other concerns, such as herbicide tolerance, pest and disease management, canola's value as a cover crop in field rotation and as a feed source for cattle. The findings will help guide decisions about this rising star on the alternative-fuel scene.

Not the least of the questions under scrutiny is profitability. Before growers plant canola in place of another crop, they need to know what kind of value they can expect to get. "Converting canola into biodiesel may not be the cheapest option because it may consume valuable land that could be used for other crops," OSU crop physiologist Brian Duggan told the *Bend Bulletin* in July.

To help gauge canola's biofuel potential for Central Oregon growers, Duggan is comparing several species for yield and oil quality. At OSU's agricultural research station in Madras, the researcher stands in a field of two-foot-high stalks topped with butter-yellow flowers. With snowcapped Mt. Jefferson as a scenic backdrop, Duggan gestures outward in several directions, indicating three additional fields, each planted with a different variety. His crop trials, funded by the Agricultural Research Foundation, are designed to reveal whether winter varieties produce more seed — and hence are more lucrative — than spring varieties.

To learn more about canola in Oregon — challenges, benefits, research — see agsci.oregonstate.edu/research/information.html

Scientists Witness Undersea Eruption

“Whoa! Oh my gosh, it’s exploding like an egg!”

As OSU volcanologist Bill Chadwick watches live images of a violent series of explosions deep in the Pacific, he searches for words that capture the otherworldly scene. “It’s like a balloon popping, or a pillow!” Chadwick is witnessing for the first time what no one has seen before: explosive eruptions of a submarine volcano.

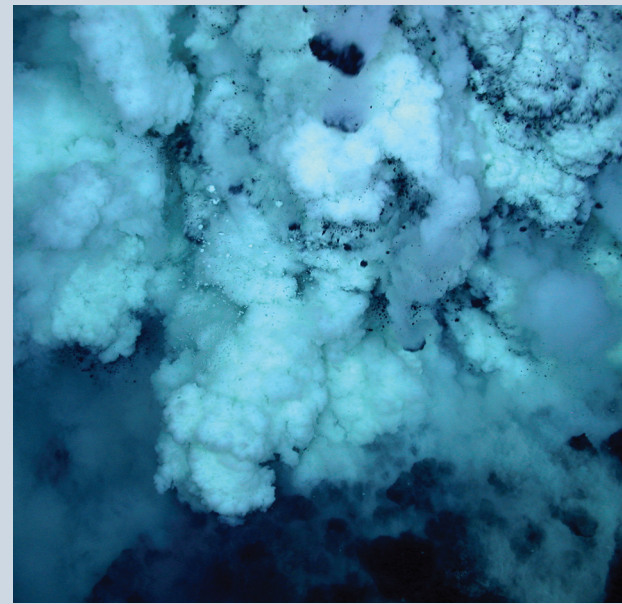
The eruption, caught on video by an international team that included OSU researchers, spewed a “pulsating, opaque, yellowish smoky plume” because it was loaded with droplets of molten sulfur, the scientists from the United States, Japan and Canada wrote in the May 2006 issue of *Nature*. The images, some taken just 10 feet from the crater by an underwater robot named Jason II, showed roiling clouds

of ash and sulfur bursting again and again from the crater, tossing huge chunks of rock around like beach balls.

All of this happened in the sunless, 1,800-foot depths near the Mariana Islands. Illuminated eerily by the robot’s search light were “characteristics unlike any known hydrothermal plume,” reported Chadwick and Robert Embley of OSU’s Hatfield Marine Science Center. The adjunct professors in OSU’s College of Oceanic and Atmospheric Sciences visited the sulfurous crater — dubbed Brimstone Pit — on expeditions between 2004 and 2006. They were funded by the National Oceanic and Atmospheric Administration, the Canadian Natural Sciences and Engineering Research Council and the Japanese Agency for Marine-Earth Science and Technology.

The findings will help scientists better understand terrestrial volcanoes, such as those in the Cascade Range.

For information about research at OSU’s Hatfield Marine Science Center, see hmsc.oregonstate.edu



An explosive burst from Brimstone Pit on the NW Rota-1 volcano throws out rocks propelled by violently expanding volcanic gases. In expeditions spanning more than two years, this volcano has been observed erupting during every visit. See expedition videos at www.oceanexplorer.noaa.gov/explorations/06fire/logs/april29/april29.html. (Image courtesy of Submarine Ring of Fire 2006 Expedition, NOAA).

Genes of Autumn

“Its leaves have been asking it from time to time, in a whisper, ‘When shall we redden?’”

Henry David Thoreau
Autumnal Tints, 1862

The magical transformation of autumn leaves inspires poets and awes observers. But the genetic triggers that produce those stunning colors have long baffled scientists.

Until now.

OSU researchers, studying aspens with scientists in Sweden and Virginia, were seeking a solution to a genetic mystery: What makes trees start reproducing after years of vegetative growth? Their vegetative state can last for more than 10 years before flowering begins, and the scientists wanted to know how trees measure that long timespan.

The international team — including Steven Strauss, a professor of forest sci-

ence and genetics at OSU — did, indeed, discover which genes control this process. But a surprise turned up: The same genes have another major function in trees’ lives — telling them when to react to shorter days in late summer and fall by beginning the critical process of winter hardening. This is when buds form, chemical changes occur and leaves often turn bright colors, enlivening landscapes.

The gene they focused on, called FLOWERING LOCUS T — FT for short — plays a key role in the control of species’ unique genetic clocks. Through eons of evolutionary adaptations to climatic niches, trees have “learned” to survive via natural selection by knowing when to turn growth on and off. So, as Thoreau observed in his beloved New England countryside, the elm, the sugar maple, the scarlet oak and the aspen all turn color at different times. Genetic adaptations to local climates, the researchers also found, cause different aspen populations to change color at different times, depending on their native latitude.

The study took advantage of the genome sequence of the poplar tree, recently completed by another team that included

two OSU graduates, Steve DiFazio and Amy Brunner. Both studies were reported last year in the journal *Science*.

The findings have promise not only for forestry and horticulture, but also for ecology and conservation, Strauss says. Scientists will be able to advance tree biology more quickly by manipulating the newly identified genetic mechanisms in the lab and studying their inheritance. Practical implications include a better understanding of climatic risks to forests, improvements to the health and yield of fruit trees and solutions to timber shortages.

Strauss is emphatic, however, that substantial social issues must first be resolved. “Because of the tight regulations on even innocuous forms of genetically modified organisms,” he cautions, “it may be difficult to put this knowledge into practice in the near future. It’s therefore as important to work on outreach as it is on advancing the science.”

To learn more about the risks and benefits of biotechnology, see OSU’s Tree Biosafety and Genomics Research Cooperative, www.cof.orst.edu/coops/tbgrc/index.htm



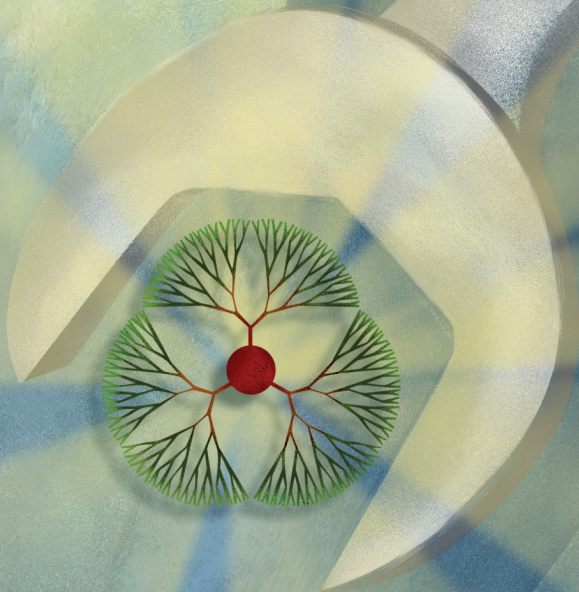
(Photo illustration: Christopher Hunter)

Small miracles

Harnessing nanotechnology

By Nick Houtman

Illustration by Santiago Uceda



Nanotechnology has arrived. No longer do we just have to imagine the benefits. Advertisers tout them in cosmetics, clothing, batteries, dental adhesives, paint and golf clubs. In 2004, nanotech consultant Lux Research, Inc., estimated the worldwide sale of products containing nanomaterials at \$158 billion. And new products are on the horizon: medicines, sensors, filters and more efficient solar collectors.

If you take a historical view, we've been driving to work on nanotechnology for the past century. About one-quarter of an automobile tire consists of nanosize-carbon black particles. Without them, our treads would lack strength and wear resistance.

"Nano" refers not just to small but to a specific kind of smallness. One nanometer is one-billionth of a meter, the width of a human hair sliced lengthwise into 100,000 strands. It takes 10 carbon atoms to span one nanometer. Lined up side by side, 152 million carbon atoms are as wide as a penny.

In 1959, Caltech physicist Richard Feynman issued a call to arms for research at this scale. He explained to a conference of his colleagues how all 24 volumes of the *Encyclopaedia Britannica* could fit on the head of a pin. Not only is there enough room among the atoms to encode that much information, he argued, "there is plenty of room," enough for all the world's books to be copied onto a mote of dust.

Among Feynman's nanotech dreams were room-sized computers shrunk to the size of a briefcase (check that one off), ingestible surgical devices that could repair a damaged heart and factories that make flawless products, atom by atom.

Today, OSU researchers in engineering, chemistry, physics and wood science are among those putting Feynman's ideas into practice. Through the Oregon Nanoscience and Microtechnologies Institute (ONAMI), they are working with colleagues at the University of Oregon, Portland State University, the Pacific Northwest National Laboratory and the private sector (HP, FEL, Intel, IBM and others) on projects designed to address manufacturing and safety issues as well as to develop new materials and products. Funding support comes from the State of Oregon and the federal government's National Nanotechnology Initiative.

The Joke Among Chemists

Among scientists, this investment is both a welcome source of support and validation of existing ideas. "The joke among the chemists is, 'have you heard about nanotechnology? It's the new name for chemistry,'" says OSU physicist Janet Tate. "We've been doing nanotechnology for a long time in physics and chemistry. A lot of what we talk about when we teach quantum mechanics is inherently nano in scale."

Tate grew up in South Africa, received her Ph.D. at Stanford and has won awards for her teaching and research since coming to OSU in 1989. A major focus has been OSU's transparent electronics initiative, nanoscale research that demonstrated the world's first transparent thin-film transistor in 2003 and integrated circuit in 2006.

"Transparent electronics is a new field, but it exploits old ideas," says Tate. It all starts with semiconductors in which the flow of electricity can be easily manipulated. Most semiconductors, such as silicon-based materials in computers, cell phones and other electronic devices, are visible because they absorb light. However, some semiconductors let particles of visible light (photons) sail right through them untouched. Thus, they are as clear as glass.

The trick with invisible semiconductors (indium oxide, zinc oxide, tin oxide and others), adds Tate, is to find ways to make them conduct electricity without making them visible. In her research, she collaborates with Doug Keszler (Chemistry), John Wager (Electrical Engineering and Computer Science) and a team of technicians and students to make transparent semiconductor films that are tens of nanometers thick. By placing other molecules into the films, they hope to achieve the kind of control over the flow of electricity that is now possible with silicon-based semiconductors.

"You inevitably shift off into the fringes where things are not quite as transparent, and you discover that maybe it's useful for something else like solar cells," Tate adds.

Common as Wood

That kind of opportunity strikes a chord with John Simonsen, a chemist in OSU's Wood Science and Engineering Department. After receiving his Ph.D. from the University of Colorado, he worked in the private sector before coming to OSU in 1990. He specialized in wood-plastic composites and wood preservatives. Strength is a problem with composites, he says, especially the bond between wood and synthetic polymers. "They just don't have the mechanical properties at the cost that we expect for building materials. You have to go to exotic polymers to get strength. You're talking dollars a pound. Wood costs a dime a pound."

So he became intrigued when he began learning about the ability of nanosize-cellulose crystals to increase strength in composites. "Cellulose crystals are stronger than steel and stiffer than aluminum. And they're renewable. That's probably why nature uses them for trees," he says.

Just as important for researchers, cellulose chemistry is well known, and, compared to many other nanoparticles, easy to work with. In his lab, Simonsen makes cellulose nanocrystals by grinding standard filter paper, then hydrolyzing it with acid. A simplified version of the process goes like this: Add acid, spin the solution in a centrifuge, then pass it through an ultrafilter to concentrate the cellulose and remove the impurities. The resulting liquid looks like watered-down milk. For show-and-tell, he keeps a vial of the cloudy liquid on his desk, telling visitors that the cellulose has remained suspended in solution for more than a year.

Simonsen uses the material in several areas of research: improving the performance of membranes, such as those in

kidney dialysis filters; improving the properties of barrier films to keep out toxic industrial chemicals; and making novel materials by combining the nanocrystalline cellulose with other polymers.

Initial findings from a dialysis membrane study by Simonsen, Sundar Atre (Industrial and Manufacturing Engineering) and Sweda Noorani, a graduate student, showed that by adding only 2 percent cellulose to the membrane, they increased both stiffness and water vapor transport, a property that should foster the ability of the filter to cleanse the blood.

In addition to his research, Simonsen is working with OSU faculty members on a nanotechnology curriculum in the Materials Science Program. A Nanotechnology Processes Option is also available in Chemical Engineering.

Nanofactories

While new materials are driving product development, Brian Paul is putting his money on “nanomanufacturing,” the ability to economically structure matter on the nanometer scale. Paul received his Ph.D. from Penn State and is a professor in the OSU Department of Industrial and Manufacturing Engineering. He specializes in bulk microfluidics, a technology that uses channels no wider than a human hair to improve the quality of chemical reactions and heat transfer.

With this technology, close proximity is key; forced into tight quarters, chemicals react quickly and uniformly. Paul and his colleagues in OSU’s Microproducts Breakthrough Institute (MBI) have found ways to sequence systems of chemical mixers, separators and heat exchangers within microchannels. In MBI research, bulk microfluidic technology has already shown promise in making biodiesel and hydrogen and in filtering blood for kidney dialysis. These microsystems are tested in labs on campus and fabricated at the ONAMI Nano/Micro Fabrication Facility on the Hewlett-Packard campus.

But what makes Paul’s eyes really light up is the microchannel synthesis of nanomaterials, such as nanoparticles called “dendrimers.” Named for their tree-like branching structure, these spherical molecules have spacious interiors and functional exteriors that can be tailored to selectively attach to surfaces. They can carry an anti-cancer drug to a tumor or lock onto the HIV virus, thus making it incapable of infecting a human cell.

Trouble is, dendrimers may take weeks to months to manufacture, and they are priced accordingly, from hundreds to hundreds of thousands of dollars per gram. Using bulk microfluidics, Paul says his OSU colleagues Chih-hung Chang

(Chemical Engineering) and Vince Remcho (Chemistry) are continuously producing multiple pounds per hour of dendrimer molecules using much less expensive capital equipment, significantly lowering the chemical cost. Moreover, the team can achieve a level of purity unmatched by industrial batch processing.

Arrays of microchannels can also address another concern that is not so nano, says Paul: safety. “Many nanoparticles are readily absorbed through the skin, and their health affects are not yet well understood. Do we really want a supply chain that is transporting them on the highways and rails? Better to transport reagents and produce the particles at the point of use to minimize exposure,” he says.

That would mean manufacturing nanoparticles in distributed reactors instead of centralized chemical plants. “What we’re talking about is distributed and portable production. We’re talking about a new paradigm, manufacturing models that blow away existing industrial scale models of production,” he adds. The challenge is finding ways to build cheap distributed systems to replace expensive centralized facilities.

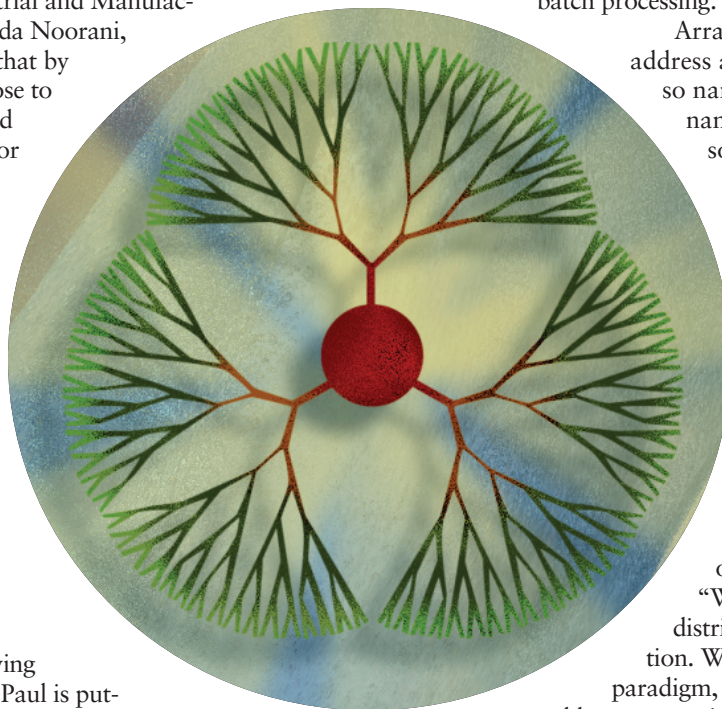
With a \$650,000 grant from the W. M. Keck Foundation, Paul, Chang and Remcho are studying microsystem-enabled dendrimer production, hoping to find new and efficient ways to apply it to a commercial scale.

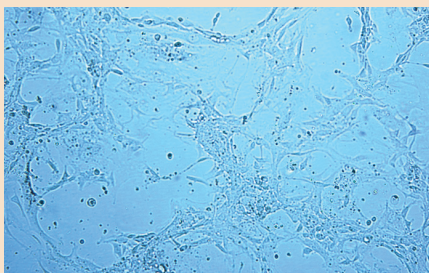
“I come from a manufacturing mindset. You can’t wait months tying up expensive capital equipment and expect to make a difference. The objective is to deploy,” says Paul.

Other OSU researchers working on nanoscale projects include Greg Rorrer, Goran Jovanovic and Christine Kelly in chemical engineering. And ONAMI is bringing them together with counterparts at the University of Oregon’s Center for Advanced Materials Characterization in Oregon and Portland State University’s Center for Nanoscience and Nanotechnology. Their private-sector colleagues include Oregon-based FEL, Inc., a world leader in electron microscopy, which enables researchers to see at the nanometer scale and even below, into the spaces between subatomic particles.

Together, they are contributing to an economic sector that could be valued at between \$1.4 trillion and \$2.6 trillion by 2015, according to recent estimates by Lux Research and the National Science Foundation. **terra**

To learn more about transparent electronics, microtechnologies and nanoscience at OSU, see engr.oregonstate.edu/research/clusters/mmd.html





Researchers will use these human umbilical vein endothelial cells to evaluate the targeting abilities of nanoparticles. (Photo: Erin Rieke)

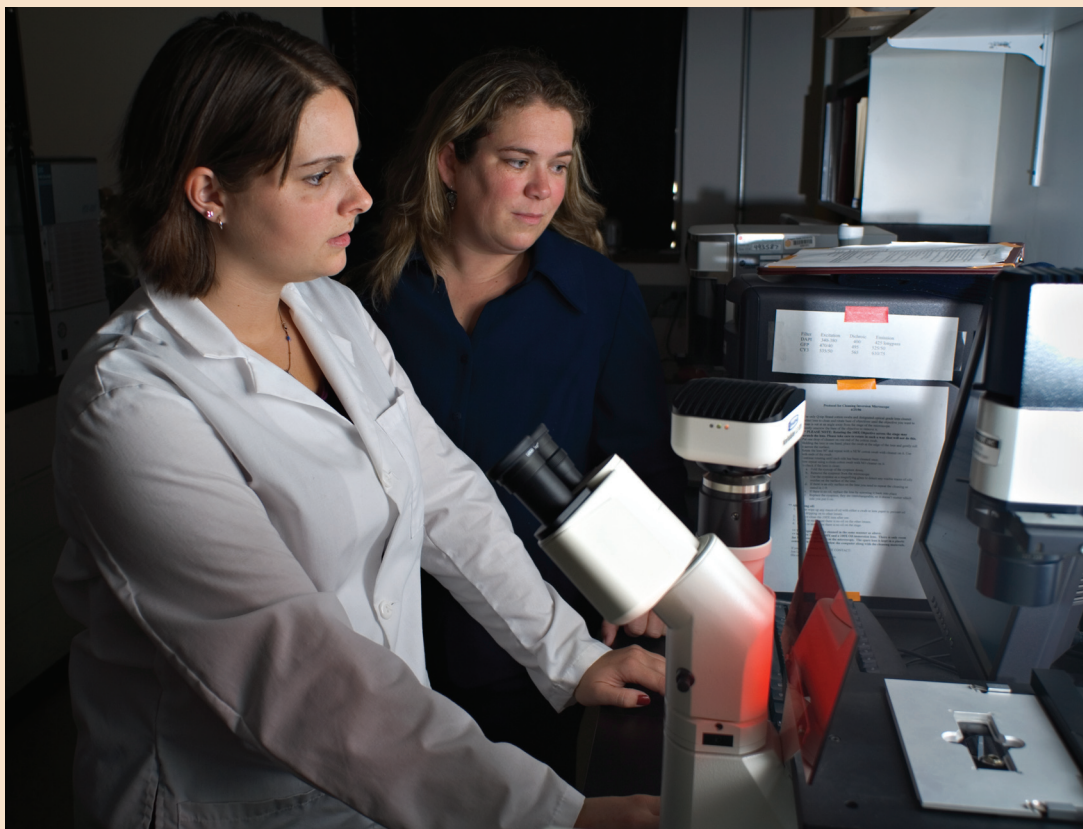
Medical Pioneer

At one time, Erin Rieke might have been hesitant to take risks, glad to let someone else step up. Hard to tell now.

The 22-year-old senior in bioengineering from Tualatin, Oregon, has been doing extraordinary things for an undergraduate: culturing breast cancer cells, exposing them to controlled doses of radiation, learning how to make nanoparticles that can circulate in the body. She loves research, but the goal for this pre-med student is to become a doctor.

“First and foremost I want to be a physician. I want to heal people. I love learning, but it’s almost useless if you can’t apply it to helping people and making advances in society,” she says. “That’s what drives me.” Rieke has convinced others of her commitment, earning an OSU Presidential Scholar award and a nationally competitive Goldwater Scholarship.

During two summers as a student in OSU’s Howard Hughes Medical Institute program, she worked with Christine Kelly, associate professor in chemical engineering, to establish a new program of breast cancer research. Kelly and her team are taking advantage of recent developments in nanotechnology to create particles that can search out cancer cells and deliver lethal medication without harming surrounding tissues. Other team members



Erin Rieke (left) has conducted much of her research in Christine Kelly’s chemical engineering lab. She has also shared her skills with younger students. As a member of OSU’s Chemical, Biological, and Environmental Engineering Student Society, she visited Oregon schools, introducing students in grades three to 12 to bioengineering concepts. (Photo: Karl Maasdam)

include Professor Stuart Helfand and Wade Edris, lab tech, in Veterinary Medicine, and Kelsey Yee, a chemical engineering graduate student.

In 2005, Rieke’s role was to learn cell-culturing techniques and to create a supply of breast cancer cells for future experiments. She then conducted irradiation experiments, applying four different tests to monitor the effects on cells.

Last summer, she and Yee synthesized nanoparticles, a promising mechanism for delivering medications. They used molecules known as “dendrimers,” growing them through successive chemical reactions, a little like adding spokes to a bicycle wheel. Other molecules — such as anti-cancer drugs and fluorescent markers — can be attached to the ends of the spokes. The work will become part of Rieke’s Honors College thesis.

Not surprisingly, there were setbacks. “Erin is very good at troubleshooting.

When things didn’t go right, she asked the right questions and searched the scientific literature for answers,” says Kelly, who asked Rieke to assist with a new course on cell culture and tissue engineering.

When she was still in high school, Rieke was attracted by challenging careers: law, medicine, engineering. “In an anatomy class, the intricacies of the human body just amazed me and blew me away,” she says. But she credits her father Ross Rieke, a civil engineer and OSU graduate (‘82), for encouraging her to consider engineering and to take chances.

“I have a lot of his engineering traits. It’s a little scary,” she says with a laugh. **terra**

To see video and slide presentations by Erin Rieke and other OSU Howard Hughes Medical Institute summer institute students, see oregonstate.edu/dept/biochem/hhmi/undergradresearch/2006/index.html



C2C participants Amy Yardley (left) a senior in business administration from Blacksburg, Virginia, and Anne Halliburton, a graduate student in sociology from Bandon, Oregon, contacted Oregon residents statewide last fall. Their survey for the OSU Extension Service measured awareness and satisfaction with Extension's mission to bring research-based knowledge to communities. C2C is part of the Austin Entrepreneurship Program in the College of Business. (Photo: Peter Krupp)

Know Thy Customer

From the executive suite to the equestrian stable, OSU student researchers are helping Northwest businesses better serve their customers.

Companies as diverse as electronics manufacturer Hewlett-Packard and peat producer Sun Gro Horticulture are looking to the College of Business for research-based services to enhance their customers' satisfaction. When HP wanted to improve user comfort with its digital projectors, and Sun Gro wished to expand its customer base for an innovative horse-bedding material, both turned to a year-old enterprise called Close to the Customer — C2C for short. Teams of students led by faculty mentors design and conduct research that start-ups or established firms can use to inform their marketing plans and guide product development.

"We help them focus," says C2C project manager Nikki Brown, who earned her master's in applied anthropology from OSU.

Although the college's Department of Marketing helped fund the launch of C2C, Brown expects the fee-for-service enterprise to become completely self-sustaining soon. In fact, it has been swamped with requests for services, from existing corporations to start-ups and nonprofits. About 25 student researchers have worked on 14 projects so far, spanning fields from health care to higher education. Even OSU's own Weatherford Residential College for aspiring entrepreneurs was a

topic of study, sponsored by a grant from the Kauffman Foundation.

The best thing about C2C, says student Lacey Gable, is its "holistic" nature. "I contributed to every aspect of the projects, from start to finish," the international marketing senior explains. For her first C2C project, for instance, her team was seeking insights into health-care consumers' attitudes and behaviors. Gable not only

"The key point of learning is to find out what the data mean. I'm seeing a lot of light-bulb moments."

Nikki Brown
C2C project manager

helped design and conduct surveys, lead focus groups, and produce PowerPoints, but she also analyzed and summarized data. "It was the whole deal," she says.

Taking research all the way is the project's greatest strength for student participants, Brown believes. "The key point of learning is to find out what the data mean," she says. "I'm seeing a lot of light-bulb moments."

Light bulbs are turning on for the clients, too. HP, for instance, learned that the digital projector's packaging and accessories had a big impact on user friendliness. "We were impressed with the online processes for tracking projector distribution and use around the campus that the student researchers generated," says HP's Steve Brown, vice president for Collaborative Networked Solutions. "The presentation of findings was very thorough and well-organized and included insightful comments from the interviews."

As for Sun Gro, North America's largest peat company, student interviews with horse owners and stable hands are filling critical information gaps.

Getting that strategic information upfront, C2C stresses, can help reduce risk in decision-making. "Less risk means fewer blunders like Ford's infamous Edsel automobile," Brown observes.

Minimizing mistakes helps maximize profits, whether the market niche is personal transportation, high-tech video equipment or even new-age livestock accessories.

To learn more about C2C services and ongoing projects, see www.bus.oregonstate.edu/programs/c2c.htm

Clear Shape Technologies License agreement

OSU's first equity license agreement involves an innovative Silicon Valley semiconductor technology company that specializes in the design automation and manufacturing of semiconductor chips.

Founded in 2003, Clear Shape Technologies, Inc., is planning to use algorithms developed by OSU researchers Terri Fiez, Karti Mayaram and others to provide additional accuracy and speed in the software designs of semiconductor chips. Clear Shape's second round of funding was led by Intel Capital with investment form KLA-Tencor Ventures as well. Cadence Design Systems is also an investor in the company.

The license agreement provides OSU with shares of Clear Shape stock in exchange for rights to the technology. Oregon Measure 10, passed in 2002, allows public universities to hold equity in start-up companies.

Reinventing High Schools

High school today is startlingly like it was in the days of “Grease.” Kids may be wearing low-rise jeans and nose rings instead of poodle skirts and letterman sweaters, but their path to a diploma looks and feels much like their parents’ — or their grandparents’.

For many students, the old ways aren’t working. Low achievement scores and high dropout rates are epidemic, especially among disadvantaged groups. To help schools reinvent themselves, OSU is collaborating with the Portland-based nonprofit Employers for Education Excellence (E3) to study schools that have broken the mold. Founded by the Oregon Business Council, E3 is funding the research with a \$100,000 grant from the Bill & Melinda Gates Foundation.

To find out how some schools create novel approaches despite cumbersome policies and long-cherished practices, researchers Michael Dalton and Molly Knott in the College of Education have interviewed nearly 60 educators in more than 20 innovative schools statewide — from rural to urban, suburban to “micropolitan.” Innovation, they have discovered, doesn’t hinge on big budgets or affluent parents or even school size. Rather, it springs from a mindset.

“Innovative schools have changed the way they think about the here and now,” says Dalton, a professor and assistant to the dean for program and research development. “They think bigger.”

He and Knott call this mindset the “Big Here” and the “Long Now.” Resources expand dramatically when “here” doesn’t mean only what’s inside the schoolhouse walls, but embraces the entire community. Kids are better served when “now” doesn’t mean the current school year, but stretches across the entire learning continuum.

“High school shouldn’t be just a box on an org chart,” says Knott. “A bigger here involves softening the edges of the box and creating partnerships. A longer now means expanding the present tense, both forward and backward.”



(Illustration: Scott Laumann)

Bigger thinking lets schools move from a “scarcity” perspective to an “abundance” perspective. Within the overlapping edges of systems (ranging from classrooms to subject areas to whole institutions), schools have access to a wealth of new resources. Borrowing the lingo of ecology, Dalton and Knott call these fertile overlaps “transition zones” — rich, diverse, teeming with possibility.

E3 is offering professional development for Oregon schools based on the findings.

But as the researchers caution, true innovation doesn’t follow a recipe. It bubbles up from the unique needs and particular goals of each school. “Invention doesn’t come from a handbook — do X,Y and Z,” says Knott. “It comes from a new way of thinking.”

See the report, including case studies of 22 schools, at www.e3smallschools.org/resources.html

Aptitude for Aging

It's personal

In 2006, the first wave of baby boomers turned 60. Even for the bold cultural warriors of the 1960s — the rockers, idealists, protesters and iconoclasts who transformed the nation — the transition to retirement is likely to be tough, according to OSU researcher Karen Hooker. Whether they thrive or struggle as they redefine their roles and restructure their time, she says, will depend largely on their personality.

The role of personality in life's trajectory has intrigued Hooker ever since her undergraduate days at Denison University in Ohio. Why, she wondered, do some people move through adulthood with relative ease, rolling with the punches, keeping a sense of purpose and hope, while others succumb to depression, addiction or hopelessness? Then, as a graduate student in developmental psychology at the College of William and Mary, the nascent field of aging captured her.

"The whole notion that development doesn't stop when you hit 21 was really just emerging," says the professor of Human Development and Family Sciences, reminiscing in her Milam Hall office.

"It wasn't on the general public's radar screen, in spite of the demographics of a growing aging population. I thought, 'Wow! This is really untapped.'"

That was the late 1970s, a time when old people were getting a bum rap in popular culture. "Everywhere you looked, there was a lot of ageism," she recalls. "If you watched TV, you didn't see very many models of old people, and the ones you did see were extremely negative."

The stereotypes of crotchety, decrepit, frumpy or demented elders didn't jibe with Hooker's own experience. Her grandmother and great-grandfather both maintained optimism, good humor, curiosity, energy and intellect throughout their



lives. She remembers watching her great-grandfather working on his Pennsylvania farm and her grandmother playing bridge with friends, well into their '90s. "They were vibrant and interesting and resilient," she says. "They were living history."

So the scholar-athlete from the Midwest (who once dreamed of becoming a gym teacher) went on to earn her Ph.D. at Penn State, followed by a post-doctoral fellowship at Duke University's Center for the Study of Aging and Human Development. Over the next quarter-century — with funding from agencies such as the National Institute on Aging, the National Institute on Mental Health and the U.S. Department of Health and Human Services

— she has delved deeply into the mysteries of personality and aging. The issues she explores with surveys, interviews, statistical analyses, and theoretical models are some of the most wrenching and life-altering in human experience — bereavement, institutionalization for dementia, mental health of Alzheimer's and Parkinson's disease caregivers, memory loss, becoming a parent, retiring from the workforce. "The thread underlying all my work is transitions — those times during the course of life when personality may act as a compass for navigating new circumstances," she says.

Ironically, her decades absorbed in aging have barely registered on Hooker's face. The lithe 50-year-old can be seen

"It's critical that we address the physical and mental well-being of our elders and their caregiving networks," says Karen Hooker, director of OSU's Center for Healthy Aging Research. Hooker's commitment to optimal aging — which she says is a lifelong process that starts with health-related behaviors such as exercising and being optimistic — is not only professional, but personal. (Photo: Karl Maasdam)

most evenings swimming laps in the campus pool or running the hills of Corvallis — the very kinds of lifestyle choices whose benefits are well-documented in the literature. Researchers know with certainty that working out, eating and drinking in moderation, and eschewing tobacco and other risky behaviors support healthy aging. They are clear about the effects of education, affluence, and ethnicity. They know, too, that engagement with life and strong social support networks are vital. Less understood, however, is how our personalities interact with these myriad factors to influence our mental and physical health over the years.

To broaden and deepen the concept of personality, Hooker has developed a theoretical model called "the six foci of personality" with Dan McAdams of Northwestern University. Published in the prestigious *Journal of Gerontology: Psychological Sciences* in 2003, the model has been adopted by universities across the U.S. as a powerful tool to guide future studies in personality and aging. That's because it weaves the various strands of personality into a whole fabric, including the life stories we construct and the narratives we tell. This new unity of personality as a multidimensional concept opens the way to more comprehensive explorations of the aging self.

"The framework lets researchers better address the full richness of personality," Hooker says. "It helps to solidify the science of personality in adulthood through a common language that had previously been elusive."

Hooker's current investigations into our "possible selves" are also yielding tantalizing clues. Self-concepts about the ideal we hope to be or the person we fear to become play critical roles as internal motivators, she explains, acting as psychological carrots and sticks in decision-making. By the time we reach old age, she has found, most of us have at least one health-related

possible self. If you carry around a mental image of yourself as, for example, a 75-year-old equestrian cantering across the landscape, or an 80-year-old bicyclist pedaling Cycle Oregon, you're better able to cope with — and fend off — that scary possible self, the bedridden nursing-home resident, Hooker says.

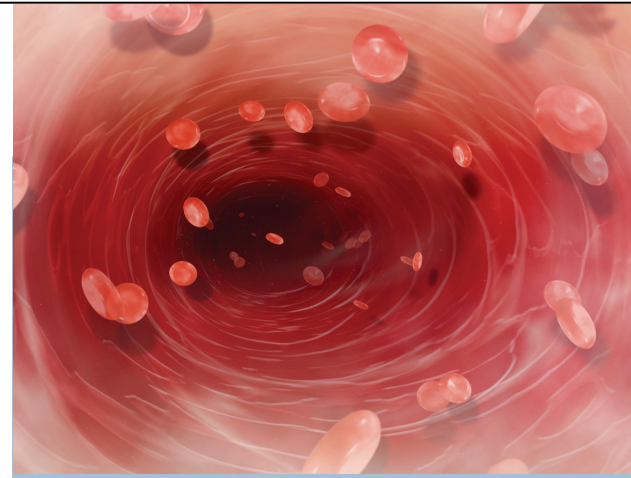
"Personality is the driving force behind successful aging," she asserts. "What type of person you are, how reliably you can be counted on, your approach to people — all are crucial for understanding social support, coping strategies, stress and other health-related behaviors."

When she uses the term "personality," Hooker isn't talking only about the traits we characterize with adjectives such as bubbly, aloof, shy or gregarious. Those outward qualities are just one side of personality. The other side is about actions — setting and achieving goals, for instance. Hooker's ongoing research and scholarship in developmental psychology is revealing how those two aspects of personality — traits ("structures") and states ("processes") — affect social and emotional adjustment in later life. Although traits are more-or-less fixed, states are dynamic. In other words, they can change. That means that useful skills for coping with retirement — such as how to structure leisure time to make it both meaningful and manageable — are teachable and learnable.

"People tend to think of personality as immutable, carved in stone," she says. "But we are finding that in fact, it's a domain where there's potential for growth, even in the very last days of life. You can always grow in some aspect of yourself."

— By Lee Sherman

To learn more about research projects in the Center for Healthy Aging Research, see www.hhs.oregonstate.edu/healthyaging/



(Illustration: ©iStockphoto.com, Rob Gentile)

Communication Breakdown

Cell signaling key to healthy arteries

Hardening of the arteries and high blood pressure may result from a breakdown in cell communications, researchers in OSU's Linus Pauling Institute have discovered. The finding could pave the way for new dietary measures and pharmaceuticals to reduce cardiovascular diseases.

"It's also a key to understanding the biological effects of inflammation, which increasingly seems to be implicated not only in heart disease but other chronic and neurologic diseases," says Tory Hagen, associate professor of biochemistry and biophysics and lead author of the study.

As they age, the cells lining artery walls no longer produce chemicals that diffuse to underlying muscle cells. As a result, vessels remain constricted, increasing blood pressure and the likelihood of cardiovascular diseases. In test tubes and animal models, the researchers identified the mechanism that impairs normal blood vessel function. The results provide new targets for therapies to prevent hardening of arteries as we age.

A diet that's heavy in fruits and vegetables seems to slow down the loss of blood vessel function, says co-author Balz Frei, director and holder of the Linus Pauling Institute Endowed Chair. The scientists also study lipoic acid, a powerful antioxidant that may play a role as a dietary supplement to help address this problem.

Their findings were published in the journal *Aging Cell* last fall.

Learn more about aging, micronutrients and health at lpi.oregonstate.edu/



(Illustration: Christopher Hunter)

Are We There Yet? The twisting road to adulthood

By Richard A. Settersten Jr.

“A 30-year-old single mother from Iowa laughed when asked whether she considered herself an adult: ‘I don’t know if I’m an adult yet. I still don’t feel quite grown up. Being an adult kind of sounds like having things, everything is kind of in a routine and on track, and I don’t feel like I’m quite on track.’”

Furstenberg Jr., F. F., S. Kennedy, V. C. McLoyd, R. G. Rumbaut, & R. Settersten. 2004. Growing up is harder to do. *Contexts*, 3(3), 33-41.

It takes longer to become an adult today, and that passage is more complicated than in the past. Our MacArthur Research Network on Transitions to Adulthood and Public Policy is focused on understanding the above passage.

In the eyes of the law and society, young people cross the threshold of adulthood at ages 18 or 21. But as our recent book *On the Frontier of Adulthood* (University of Chicago Press, 2005) reveals, few 21-year-olds today would actually be considered “adult” based on traditional markers such as leaving home, finishing school, starting a job, getting married and having children.

A lengthy period before adulthood, often spanning the 20s and even extending into the 30s, is now devoted to further education, job searching and exploration, experience in romantic relationships and personal development. But we should not take these changes to mean that the early adult years are now an extended “moratorium” characterized by pervasive experimentation and the avoidance of commitments.

To be sure, a subset of young adults falls into this category. But most of the

young people in our studies are seeking responsibility, negotiating autonomy, making commitments, nurturing relationships and finding ways to contribute to their communities. Yet many *are* having a difficult time finding their way, and it is taking them much longer to get there.

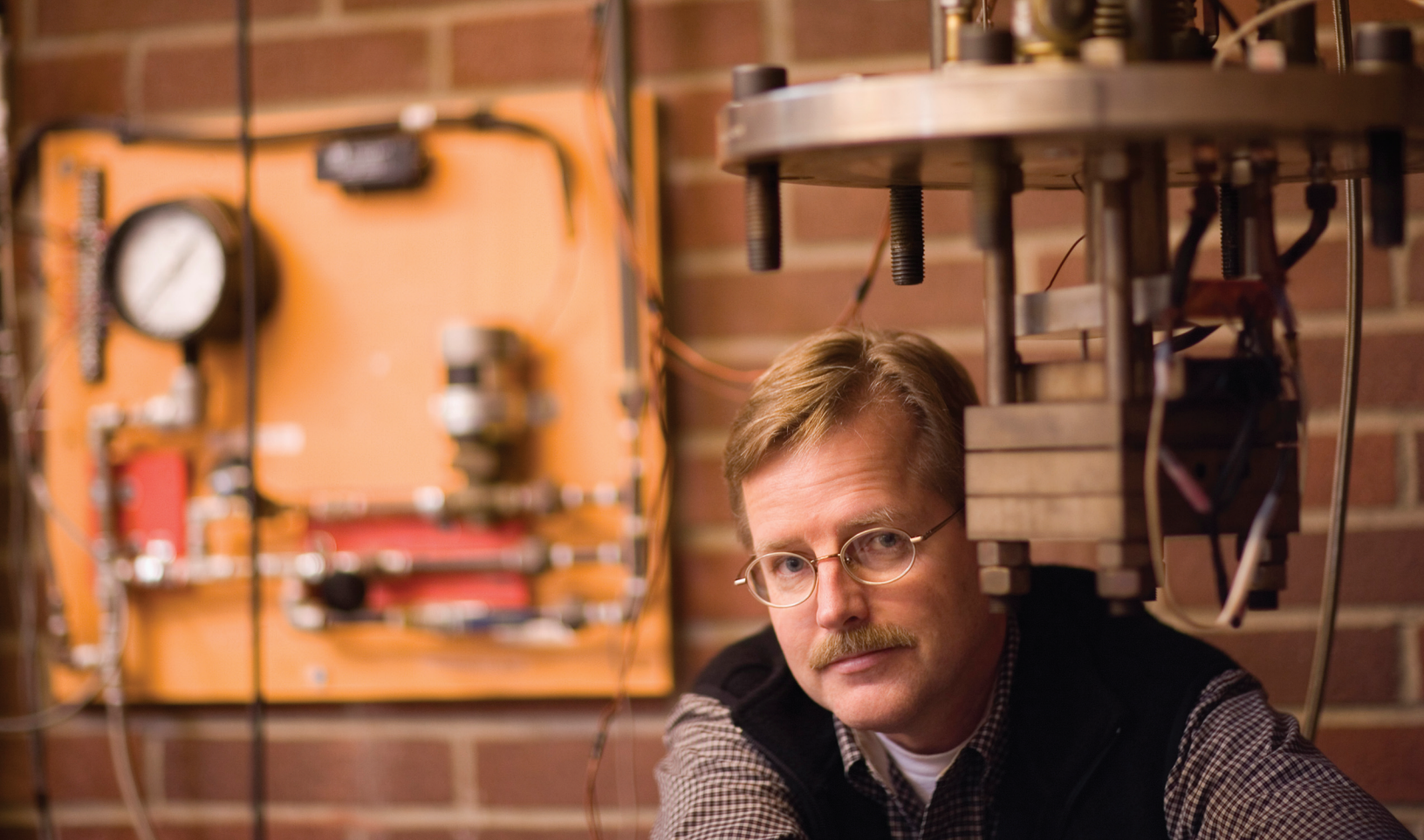
The new terrain of early adulthood carries tremendous social and cultural significance. For many young adults, navigating this transition phase is often possible only with significant family support. Accordingly, sizeable child-rearing costs now occur between the ages of 18 and 34, and they have increased dramatically in the last 30 years. While middle-class families make substantial investments in their children through their 30s, the fate of young people who come from struggling or fragmented families is therefore of great concern.

We must especially be concerned about the fate of young people who have been in the foster care, special education or juvenile justice systems and are abruptly cut off from state support when they hit age 18 or 21. These young people are without any safety nets whatsoever. Our network closely examined the struggles of these and other vulnerable populations in the subsequent book, *On Your Own Without a Net* (University of Chicago Press, 2005).

Our work is now focused on how social institutions and policies might be redesigned to more appropriately meet the needs of young people, and how the capacities of young people themselves might be strengthened so that they are better equipped to make their way.

Richard A. Settersten Jr. is a professor of Human Development and Family Sciences and a member of the MacArthur Research Network on Transitions to Adulthood and Public Policy.

For more information on the MacArthur Research Network on Transitions to Adulthood and Public Policy, see www.transad.pop.upenn.edu



Pressure's On High-strength building products

It was a great idea, just ahead of its time. More than 50 years ago, engineers came up with a way to increase the strength and stiffness of wood. By applying steam, heat and pressure, they increased strength by about 250 percent. Problem was, strong wood was in plentiful supply. So, except for some minor applications, the technology languished.

But that is changing.

Fred Kamke, professor in the OSU Department of Wood Science and Engineering, has now improved the process, achieving strength increases up to 400 percent, taking less time and using less mechanical force. He has applied for a patent on the technique, known as viscoelastic thermal compression, or VTC. The strength and stiffness of VTC wood is better than the best available Douglas fir.

This time around, the stars may be aligned for wood processed in this manner. Demand for wood products is rising, and supplies of high-strength timber are dropping. "When you can find it, you pay a high price for it," says Kamke, who holds the JELD-WEN Chair in Wood-Based Composites Science at OSU.

In the Northwest, opportunity knocks on thousands of acres of fast-growing hybrid poplar. Oregon has about 20,000 acres, originally intended for the pulp and paper industry. Now, the low price of pulp has landowners looking for a more valuable way to use the wood. But hybrid poplar is weak, as useful as jelly for load-bearing structural components.

Kamke has used the VTC process to create a high-strength hybrid poplar composite. "The VTC wood is strategically placed where needed most in the composite. It may be bonded to 'normal' wood, which more or less acts as a filler," says Kamke.

Businesses are now showing interest in using VTC wood materials in new wood products. "I can see uses for it in building construction, and I think there could be applications for flooring materials because it has good hardness properties," Kamke adds.

In addition to VTC technology, Kamke studies wood adhesives, a critical element of engineered wood composites. Despite thousands of years of experience with wood glues (starting with the ancient Egyptians), the chemical and physical details of how they work are poorly known. Better understanding, Kamke adds, could pave the way for stronger and more durable building products.

Wood composites are the fastest growing segment of the forest products industry. Through its endowment, Klamath Falls-based JELD-WEN (the country's second-largest window and door manufacturer) has shown its commitment to helping Oregon take advantage of that trend. "JELD-WEN values research and innovation and has a long history of working with and supporting Oregon State," says Kamke.

OSU
Foundation
OREGON STATE UNIVERSITY
Online: osufoundation.org

In Corvallis: 850 SW 35th Street
Corvallis, OR 97333
Voice 541-737-4218
Toll Free 800-354-7281
Fax 541-737-0498

In Portland: 707 SW Washington, Suite 500,
Portland, OR 97205
Voice 503-241-9333
Toll Free 866-218-8930
Fax 503-553-3454



Only two and a half square miles in area, King Island is “barely a dot” in the Bering Sea. This was the observation of frontier photographer Edward S. Curtis, who documented Inupiat cultures in the 1920s. Eight decades later, OSU anthropologist Deanna Paniataaq Kingston is leading a study to gather and preserve the traditional ecological knowledge of King Islanders. See “The Ice Sages,” page 2. (Photo: Matt Ganley)

Listen to OSU researchers, follow their stories and see more photos, at oregonstate.edu/terra



Terra
416 Kerr Administration Building
Oregon State University
Corvallis, OR 97331

NON-PROFIT ORG. U.S. POSTAGE PAID CORVALLIS, OR PERMIT NO. 200
--