INQUIRY

Information from the frontiers of knowledge

A magazine highlighting research at the University of Oregon

Summer 1999, Volume IV, Number 2

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Summer 1999

A Message About Research From

Tom Dyke
Vice Provost for Research

The inner workings of the mind, the settling of the New World, the digital future–research at the University of Oregon is leading to new knowledge in each of these important areas of human understanding.

Digital information is one of the most powerful tools scientists and researchers use to explore the frontiers of knowledge. Of the six UO research efforts highlighted in the following pages, four leverage advances in digital technological to create wholly new and original advances.

This work ranges across many fields: developing a more powerful Internet; using today's Internet to improve pilot training and flight safety; designing biology-based microchips to better understand the brain; and creating new works of art, not with paints or pencils, but with advanced hardware and software.

Inquiry also features advances made using more traditional tools–from the archeologist's pick and shovel to the careful interviewing techniques of the psychologist.

But regardless of the tool, the process is the same: our researchers are using their creativity to increase understanding. And with that increase comes new possibilities, new beneficial applications, and new questions for tomorrow's researchers to ask, to wrestle with, to answer.

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Summer 1999

The Science of Safer Skies

Investigating the Decisions that Make Sharper Pilots, Safer Flights

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Although safety is designed into all kinds of airplanes–from top-gun fighters to jumbo jetliners to single-engine prop planes–tragedies still occur. But if research being conducted by Robert Mauro, a University of Oregon associate professor of psychology is a success, we may be en route to better pilots and safer skies.

Robert Mauro

"We are looking at how pilots make their decisions–the good decisions and the bad ones," says Mauro, who is head of the UO psychology department and a member of the Institute of Cognitive and Decision Sciences. "These are important questions because most air crashes are due to human error."

Surprisingly little is known about how experts make decisions. For decades, psychologists have conducted decision-making studies in laboratories by using college student volunteers who are asked to work on problems far removed from everyday life. But these studies, relying upon so-called "naïve" subjects, do not reflect how decisions are made by experts such as pilots.

"Researchers began to realize that people in the real world frequently do not make decisions the way student subjects do in the laboratory," Mauro notes. "As a result, such questions as ‘How do people solve important problems?’ and ‘How do we encourage good decision-making and discourage bad?’ have remained largely unanswered."

.So Mauro decided to study experts. A licensed pilot himself, his idea was to examine the decision-making processes–choices of potentially life-and-death significance–of airplane pilots. A good idea, but how to pull it off?

."Pilots tend to be quite busy people and not usually located in proximity to psychology labs," Mauro explains. "We needed to figure out how to get the laboratory to the subject."

.The answer turned out to be the World Wide Web.

.In August 1998 Mauro brought the idea for the project to the staff of the UO New Media Center (NMC), a group that uses the latest digital technologies to create innovative multimedia applications. Mauro asked if New Media Center experts could help him devise a system that would work on the Internet and meet a number of other requirements. Could such an interactive system guarantee the confidentiality of the subjects' responses? Could it measure the time it took each subject to examine different sources of information and make a decision? Could it record the multiple stages of decision-making?

.The technical challenges appealed to NMC staff and student workers, who enjoy stressing the "new" in "New Media." In the words of technology manager Harold Hersey, "If we're not breaking ground on every new project, we're doing something wrong."

.Mauro and the NMC's technical and graphic design staff set to work creating an environment that functionally simulates a pilot's preflight and in-flight experience with maps, weather reports, and interactions with air traffic controllers. Audio effects such as engine hum and visual indicators such as clouds enhance the simulation. In the end, the NMC was able to meet all of Mauro's requirements, and the Internet-based Decision Research System (IDRS) was born.

. Once final testing and tweaking are completed, a pilot anywhere in the world will be able to access IDRS via the Internet and take part in the research. It takes only about a half hour for the subject to complete the full simulation, yet it yields a huge amount of information. For example, what information did the pilot skip over and what was most closely examined, when were final decisions arrived at and with what sense of certainty? The data gathered from each pilot are pooled with those from other pilots in a research database.

."The database will be large enough to support significant analysis that should tell us a great deal about the decision-making process," Mauro says.

. Mauro is interested in applying his work to improved pilot training and flight safety. But as a decision scientist, he is also excited by the prospect of extending his new web-based testing method to other areas of study.

. "With very little alteration, the design developed in this work with the New Media Center opens the door to the study of all kinds of other interesting groups who make important decisions–physicians as they make diagnoses, CEOs as they guide corporations, stock brokers as they recommend purchases and sales, generals as they consider military action–the list goes on."

. Mauro stresses that basic research becomes the stepping stone for beneficial applications.

. "Once we fully understand how these processes work–and they may work quite differently in various fields–the next step will be to devise improved methods for teaching. Better training may allow novices to become experts in a shorter period of time than has been possible in the past. Safer skies may only be the beginning."

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The Department of Psychology *at the University of Oregon*

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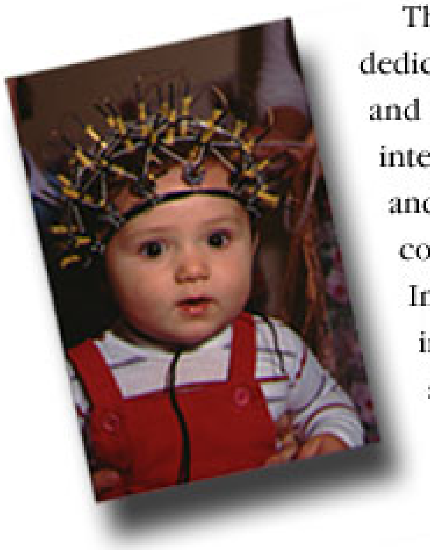

The Institute of Cognitive and Decision Sciences is dedicated to exploring the workings of the mind and brain and how they affect human behavior and social interaction. Our goals are to advance the empirical study and theoretical understanding of cognition, culture, and communication from an interdisciplinary perspective. In pursuing those goals, the Institute will promote the integration of diverse methods and theories from the social, human, and life sciences.

Focus Groups

The Institute is organized around the following focus groups:

- **Group Formation and Collective Action**
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- **Event Representation**
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The **University of Oregon Interactive Media Group**, formed from the original New Media Center and now part of **Media Services**, develops a range of full-service technology design and consulting solutions for faculty research and instructional use. Our cross-disciplinary team designs and develops new media projects for interactive courseware and promotional purposes, and consults with faculty members on the instructional use of creative technology.

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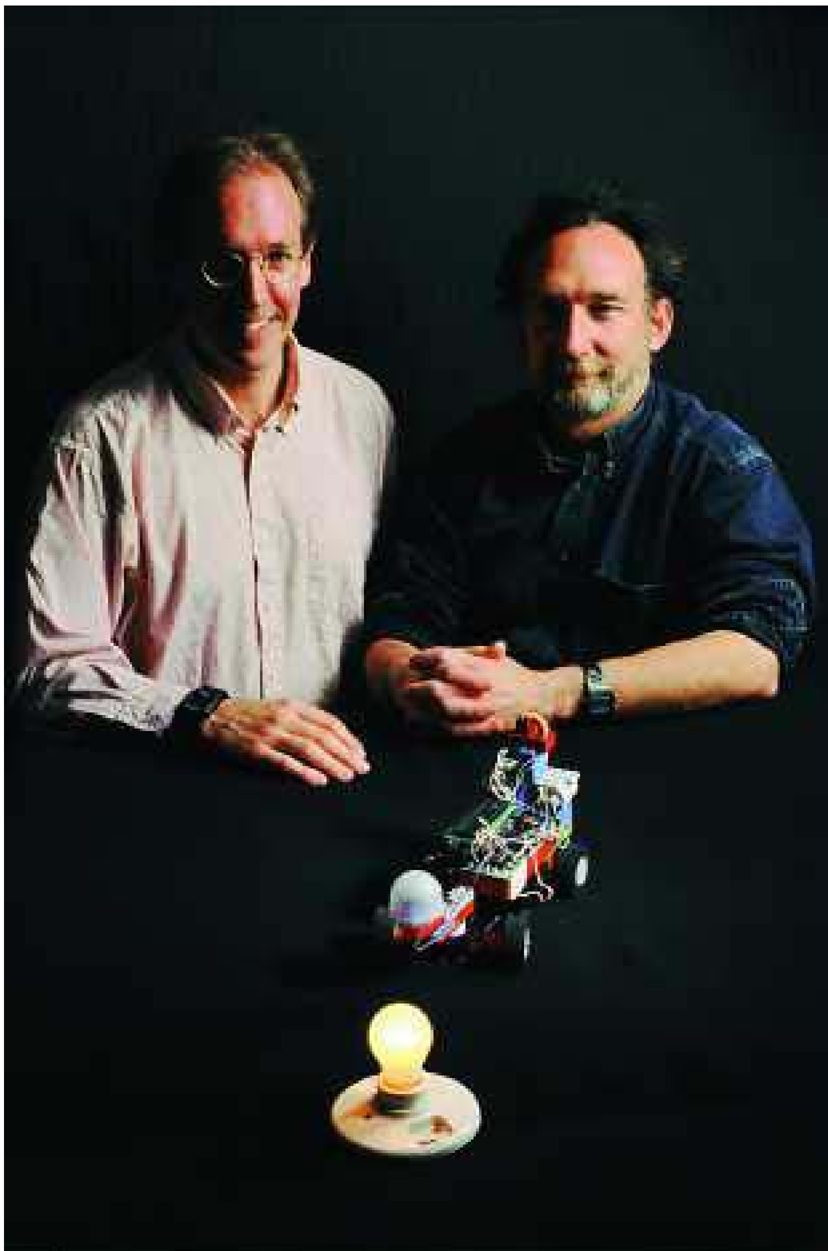
Worm Brain Drives Tiny Car

Biologist Mixes Mind and Microchip to Create "Biobot"



Tom Morse and Shawn Lockery

.The little brightly colored car roaming across the floor of Shawn Lockery's laboratory looks like the baby brother of NASA's Pathfinder, the toaster oven-sized robot that rolled across the surface of Mars, beaming back to Earth those famous red-rock landscapes. But instead of extending our understanding of another planet, the vehicle in Lockery's lab is exploring uncharted territory within the brain.

. The car is a "biobot," a hybrid of biology and robotics.

.The robotic elements are plain enough to see: a small electric engine, batteries for power, and a conventional steering mechanism. What has drawn so much attention to the biobot–including the cover story in a recent issue of *Popular Science* magazine and a feature article in the *Washington Post*–is its guidance system. Lockery and his associates have, in essence, been able to put the microscopic brain of a microscopic worm in the driver's seat.

.Over the years, this particular

worm, a nematode known as *C. elegans,* has attracted a staggering amount of scientific attention.

."*C. elegans* has one of the least complex nervous systems of any life form on the planet," says Lockery, a University of Oregon biologist who has studied the worm for twenty years. "Its brain has only 302 neurons, or brain cells; that's compared to about a hundred billion neurons in a human's brain. It is the only animal for which we have a complete map of the brain. It is likely to become the first animal for which we can gain a fairly complete understanding of how the brain controls behavior."

.One of the behaviors Lockery is most interested in–and which he and his coworkers have harnessed to drive the robot car–is the worm's primitive feeding instinct. This instinct, technically termed chemotaxis, helps the worm zero in on likely sources of food. But in sharp contrast to a visually oriented human–who might spot a desirable apple, walk straight toward it, and take a bite–the worm sniffs out its food in a meandering, indirect manner. The scant information the worm's tiny brain works with is similar to what a participant in the children's game gets from the clue "warmer" when approaching the hidden object or "colder" when searching in the wrong direction.

."We have replicated the chemotaxis circuitry of the worm's brain on a microchip," Lockery explains. "But we have made one switch. We made it so that instead of plotting a course to bring it closer to food, our robot searches out light."

.Prominently placed on the front end of the car is a light sensor. It gathers information–"more light this way" or "darker over here"–and sends it to the microchip brain. The brain turns the information into action in the form of guiding the robot forward until new information suggests a change of course.

."The question of how the brain controls behavior is of immense scientific and medical interest," Lockery notes.

.While some researchers are addressing the question by examining human brains with powerful tools such as magnetic resonance imaging (MRI), computerized axial tomography (CAT) scans and positron emission tomography (PET) scans, his laboratory is taking a different approach. By studying the worm's rudimentary brain, his group is learning how a neural system works as a whole. Getting this fundamental grasp of how the system functions will be extremely helpful to other researchers working out the mechanics of more and more complex brains–all the way up to those in humans.

."A simple model, such as the worm's brain, is a powerful research tool for learning about the role of whole systems as well as for studying the importance of individual molecules," Lockery says. "Researchers trying to unravel the complex chemical and molecular bases of diseases such as Alzheimer's need a precise understanding of how individual molecules affect the brain. This kind of understanding will come from investigating simple model systems like the worm."

.Aside from the biomedical advances associated with brain research, Lockery’s biobot may also have some very practical applications. The U.S. Navy is funding some of this research out of an interest in developing improved minesweeping methods to make shipping and amphibious landings safer. Artificial fish using a biochip programmed to home in on faint traces of explosives could be released into a mined harbor. Upon finding the mine, the fish could emit an alert signal and serve as a beacon for mine-clearing activities.

.With a variation in programming, these robotic fish could be useful in environmental cleanup by zeroing in on oil or chemical spills.

."The idea of learning from nature makes a great deal of sense," Lockery says. "Evolution has been at work improving these brains for millions of years while we’ve only been designing chips for a few decades."

.The robotic car has gone through a rapid evolution of its own. Early contributions by postdoctoral research fellow Thomas Ferree helped get an early prototype rolling back in 1997. Tom Morse, another postdoctoral fellow who continues to work on the biobot project, collaborated with Lockery on the programming and construction of more advanced models.

."Through the development of this car we now understand much better how the worm’s 302 neurons work together," Lockery says. "The next step is to build on what we’ve already discovered to come to a fuller understanding of how they function individually. The car is the perfect (pardon the pun) vehicle for that research."

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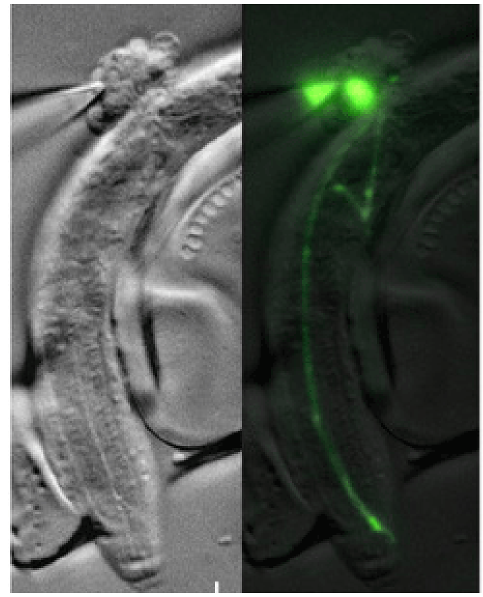
We study how the nervous system controls behavior by analyzing the simple neural network that controls chemotaxis, a form of spatial orientation behavior, in the nematode worm *Caenorhabditis elegans.*

Current and future research will seek to determine (1) the mechanism of chemosensory signal transduction in C. elegans, (2) the behavioral and electrophysiological roles of ion channels in chemotaxis neurons, and (3) how the chemotaxis network integrates information through time.



"What we have before us are some breathtaking opportunities, disguised as insoluable problems"
--John Gardner

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Last modified 06/12/02 by amiller@uoneuro.uoregon.edu

Simple Nematode May Give Navy a New Way to Find Mines

By Louis Jacobson
Special to The Washington Post
Monday, August 24, 1998; Page A03

EUGENE, Ore.—At first glance, the worm known as Caenorhabditis elegans seems humble enough. Unlike its disease-causing and crop-killing cousins in the nematode family, C. elegans -- which reaches at most a millimeter in length -- is a peaceable resident of temperate soils. Its body is clear to the point of transparency. It rarely lives more than 18 days, and it mates with itself before it passes on.

But to researchers at the intersection of biology, chemistry, physics and engineering, C. elegans is invaluable. Scientists at the University of Oregon -- funded in part by the Navy -- are utilizing C. elegans's brain wiring to run an electronic robot that could one day be a model for a cheap, artificial eel that can locate explosive mines at sea.

Their eel would be built with a computerized brain that allows it to think, sniff and move as efficiently as C. elegans does. Much like the fruit fly, Drosophila melanogaster, C. elegans became a scientific star because it is both physiologi cally simple and has a quick reproductive cycle.

Scientists were able to map C. elegans's synapses -- the message-bearing connections within its nervous system -- because it has a mere 302 neurons, or nerve cells. By comparison, humans have 1 trillion. Despite its tiny brain, C. elegans is pretty smart for its world. If one adjusts for the nematode's smaller size, C. elegans can actually handle about 1,000 times as much information per second as an Intel Pentium processor can.

That comparison, conceived and jotted down by University of Oregon neuroscientist Shawn R. Lockery a few years ago, "supported the idea that there are really important engineering secrets hidden in an animal system," Lockery said.

Thinking about artificial intelligence that way represents a sharp break from the past. Historically, scientists have tried to fashion electronic systems into approximations of animal behaviors. By contrast, Lockery and his team are trying to hard-wire the principles of animal brains into the instructions that run electronic robots.

"We don't call it artificial intelligence -- we call it biological intelligence," said Joel L. Davis, a program officer with the Office of Naval Research, which has funded Lockery's work. "Our goal is to look at the animal kingdom for behaviors or capabilities that we can reverse-engineer into devices that solve real-world Navy problems."

Several other federal agencies, including the Defense Advanced Research Projects Agency (DARPA) and the National Institutes of Health, have followed the Navy's lead on biological intelligence, Davis said.

The Navy and DARPA have funded efforts by Joseph Ayres to pry into the minds of lobsters and lampreys. Lobsters are famed for their skill at moving through rocky, underwater surfaces buffeted by heavy water currents. Ayres, of Northeastern University's marine biology station in Nahant, Mass., has studied the simple "pattern generator" in the lobster's neural networks that governs how each leg moves.

The goal, Davis says, is to use a synthetic copy of the lobster's pattern generator to drive an artificial lobster that could one day be a prototype for an autonomous undersea vehicle. Early versions of the simulated lobster body and legs are complete and are scheduled for testing this summer, Davis says.

Similarly, the lamprey -- a relatively primitive sea creature -- might eventually provide scientists with clues about mimicking the movements of fish. Ayres is studying how the lamprey's brain controls its sine-wave-like movements, but the project is still in an early stage. "We'd like to create a device where the movement of the body mimics the flex of a fish," Davis said.

The focus of Lockery's lab is a process known as chemotaxis -- the method animals use to follow smells or tastes. A blindfolded man finding his way toward a just-baked apple pie uses chemotaxis to decide which direction to move. Similarly, nematodes use chemotaxis to find bacterial food sources by following the odors of their favorite bacteria's chemical byproducts. Chemotaxis, Lockery says, "is arguably the most widespread form of goal-directed behavior -- that is, intelligent behavior -- in the animal world."

To figure out how nematodes practiced chemotaxis, Lockery and lab mates Thomas Morse and Jonathan Pierce constructed chemical gradients for their worms to wander through. What they found is that nematodes forged ahead as long as they were finding equal- or higher-strength odors that they liked. As soon as the odor began to abate even slightly, the worms spun around. If their new direction offered stronger odors, they continued in that direction. But if the odors proved to be weaker still, the nematode kept spinning until it found a direction that offered more of what it wanted.

Once Lockery and his lab mates understood that process, they wrote computer instructions that mimicked the behavior and installed them in a $350 makeshift robot made of Lego tiles, model airplane parts, a light sensor and the plastic canister from a gumball-machine prize. The foot-long robot moves exactly as a nematode would under a microscope: It meanders haltingly, but within a minute or two, it always winds up at the brightest light source in the room.

Eventually, Lockery -- and the Navy -- would like to adapt that sensing system to track the minuscule plumes of waterborne chemicals that leach from underwater mines. To do that, they would embed a microchip containing the nematode's chemotaxis instructions into an eel-like robot fitted with a chemical sensor.

The little Lego robot -- though it's only "phase one, if not phase zero" of Lockery's project -- has already showcased how eons of evolution come up with ingenious solutions. For instance, Lockery unexpectedly discovered that C. elegans and its robot progeny use an elegant method to right themselves once they have hit an obstacle. When the robot hits a chair or a bookcase, it doesn't remain stuck for long, even though the light level at that spot, to the naked eye at least, seems constant. In reality, the light level is always fluctuating slightly, so before long it usually drops low enough for the brain to conclude that it's time to turn around.

Building a real-life mine detector from Lockery's research "is possible," said Anne Hart, a neuroscientist who studies C. elegans at Harvard Medical School and Massachusetts General Hospital. "But either way, we're going to learn a lot. The fundamental mechanisms behind chemosensation in C. elegans seem to be the same as for humans. And it's a lot easier to learn those principles from a worm."

Faculty

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Shawn Lockery

Assistant Professor, Department of Biology
B.A., 1981, Yale; Ph.D., 1989, University of California, San Diego

Research Interests

Neuronal and genetic basis of behavior

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We study how the nervous system controls behavior by analyzing the neural networks that control chemotaxis and thermotaxis, simple forms of spatial orientation behavior, in the nematode worm Caenorhabditis elegans.

We investigate how these networks function using a combination of experimental and theoretical approaches. We track the movements of normal and mutant worms at high spatial and temporal resolution to determine the behavioral strategies underlying spatial orientation in C. elegans. Individual neurons in the networks are killed with a laser microbeam to identify their role in behavior. Patch-clamp and optical recordings are made from normal and mutant animals to determine the electrical properties of neurons and their activity patterns as the animal responds to natural sensory inputs. Data generated by the experimental approaches are synthesized in theoretical models of the spatial orientation networks. Predictions from the models are tested experimentally and the results are used to improve our theoretical understanding of the function of biological networks. These results provide new insights into the cellular and molecular mechanisms of information processing underlying animal behavior.

Concentration clamp movie

http://chinook.uoregon.edu/images/wormchemostep.mov

A key step in the neuronal analysis of a behavior is to identify its sensorimotor transformation, i.e. the function that relates the amplitude and waveform of the stimulus to the amplitude and waveform of the response. To study the this transformation, we devised a *concentration clamp* that delivers rapid changes in attractant concentration to unrestrained worms crawling on a typical substrate. This was done by placing worms individually on a thin porous membrane supported over a yoked pair of miniature, inverted showerheads. Each showerhead emitted an attractive salt solution with a different salt concentration. Step-wise changes in salt concentration were delivered by sliding the showerhead assembly relative to the worm. Using this new device, we found that the step response is consistent with chemotaxis toward regions of high salt concentration, exhibits distinct early and late phases, varies nonlinearly with the sign and amplitude of the step, and is altered by experience and neuronal ablation. These results offer some of the first insights into how the sensorimotor transformation might be computed at the level of individual neurons.

Representative Publications

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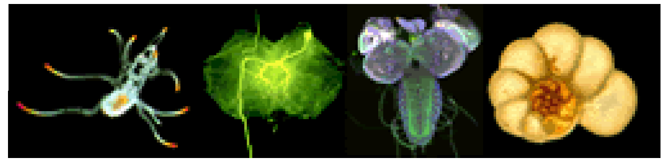
- Dunn NA, Lockery SR, Pierce-Shimomura JT, Conery JS. (2004) A neural network model of chemotaxis predicts functions of synaptic connections in the nematode *Caenorhabditis elegans* . *J Comput Neurosci.* 17(**2**):137-47.
- Zariwala, H.A., Miller, A.C., Faumont, S., and Lockery, S.R. (2003) Step response analysis of thermotaxis in *Caenorhabditis elegans*. *J. Neurosci.* **23**:4369-4377.
- Pierce-Shimomura, J.T., Faumont, S., Gaston, M.R., Pearson, B.J., and Lockery, S.R. (2001) The homeobox gene *lim-6* is required for distinct chemosensory representations in *C. elegans*. *Nature* **412**:566.
-
- Ferree, T.C. and Lockery, S.R. (1999) Computational rules for chemotaxis in the nematode *C. elegans*. *J. Computat. Neurosci.* **6**:263-277.
- Pierce-Shimomura, J.T., Morse, T.M., and Lockery, S.R. (1999) The fundamental role of pirouettes in *C. elegans* chemotaxis. *J. Neurosci.* **19**:9557-9569.
- Goodman, M.B., Hall, D.H., Avery, L., and Lockery, S.R. (1998) Active currents regulate sensitivity and dynamic range in *C. elegans* neurons. *Neuron* **20**:763-772.
-

Lab Publications

- Coleman, C.C. (2003) Neural network models of thermotaxis in the nematode *C. elegans.* Undergraduate Honors Thesis.

Updated: January 13, 2005
Contact: todd@uoneuro.uoregon.edu

The Department of Biology



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 Webmaster

Tracking Nematode Movement Using Image-Pro Plus and Stage-Pro

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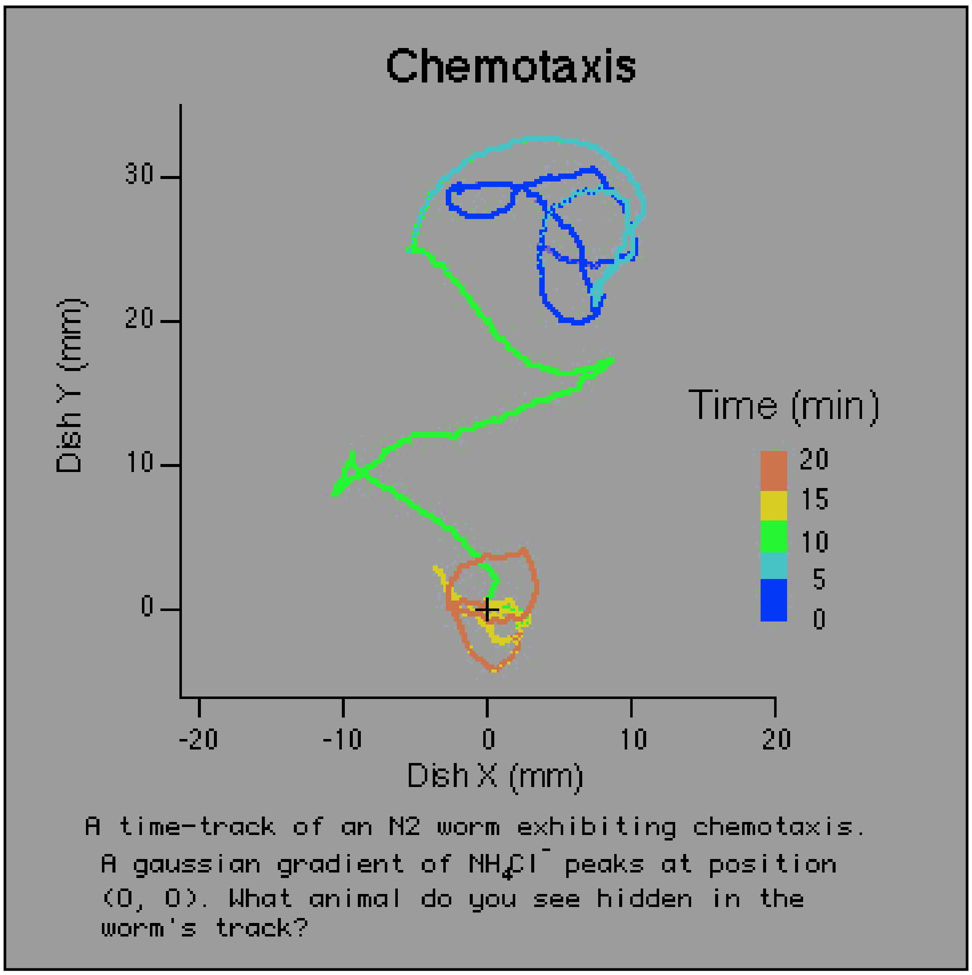
Note # 131

I am interested in the neurological basis of behavior. One behavior that has always fascinated me is how animals appear to "know" where they are going, and often times travel many times their body length to get to their goal. How are nervous systems "wired" to complete this difficult task? My research uses the nematode C. elegans to attempt to answer this question in a model organism.

C. elegans exhibits a goal-oriented behavior called chemotaxis where they orient their movement up a gradient of attractant chemical in an

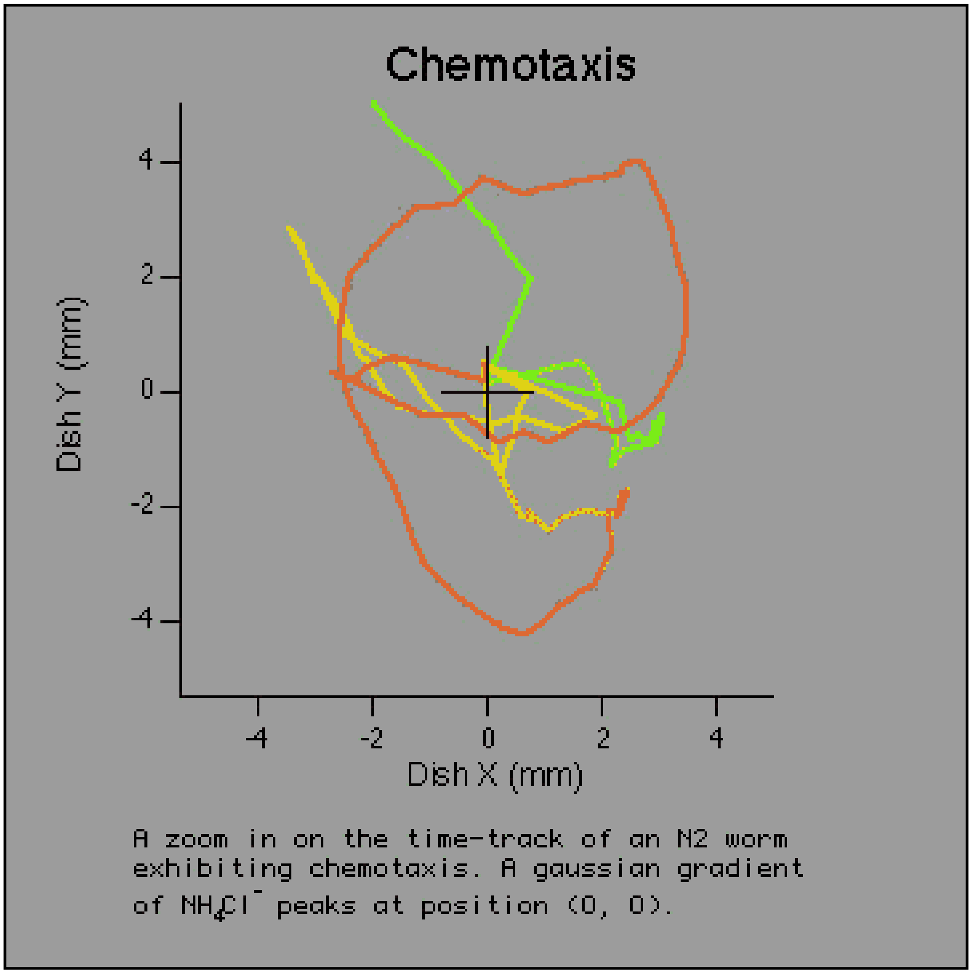
Wormtracker Plots

The worm tracks were plotted using IGOR Pro v. 3. The data was collected using Image-Pro Plus with Stage-Pro. Thanks go to **Tom Morse** for his help on the Wormtracker.



A time-track of an N2 worm doing chemotaxis in a chloride gradient.

agar dish. Worms will often crawl up a gradient of attractant and then dwell there for minutes at a time. Adult C. elegans are able to crawl about 25 times their body-length per minute.

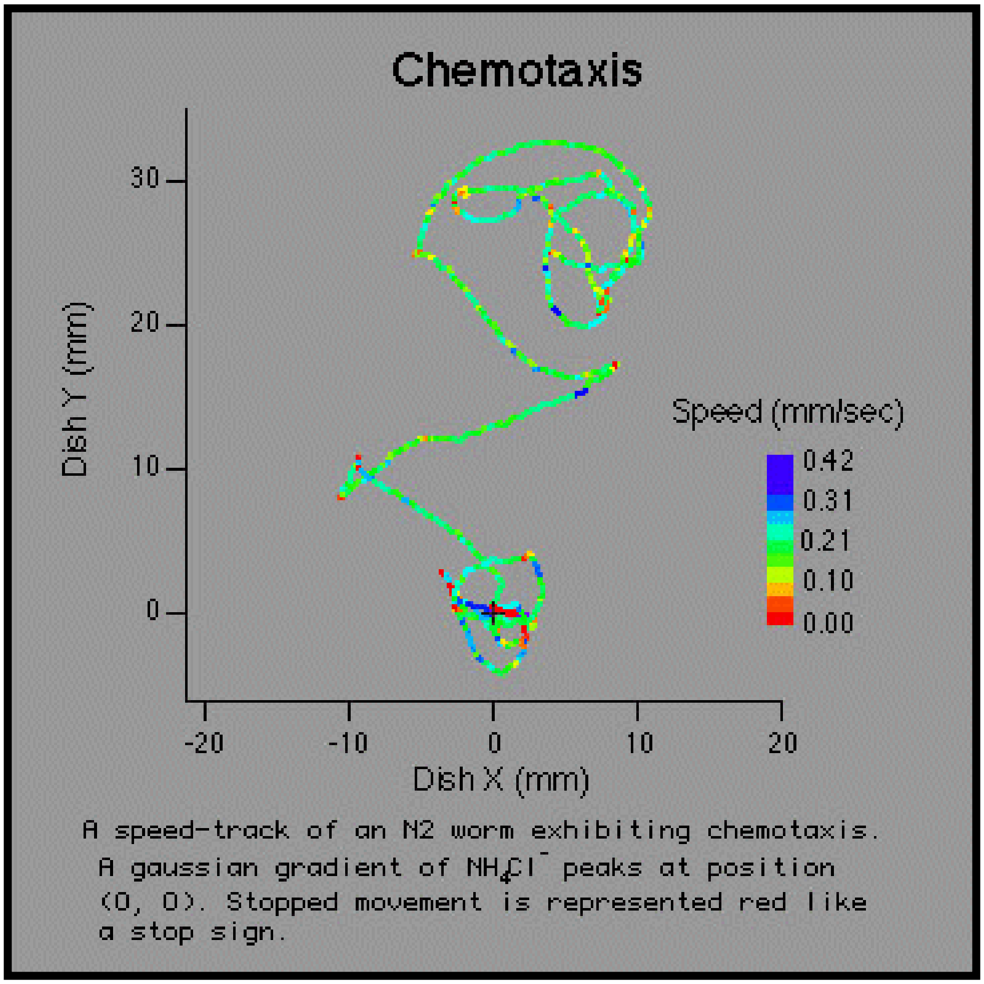


A magnified picture of the same worm track at the center of the gradient.

Studying their motion is difficult since worms are about 1 mm long, translucent, and difficult to see when crawling long distances on the agar. To solve this problem I have completed the Worm Tracker, a system that automatically follows the worm's motion and records it's position over time. By video taping the experiment, I may also go back and analyze any part in more detail.

The track is made up of about 1000 points; each of which was a centroid of the worm as reported by Image-Pro Plus at a different point in time. I've written a Visual Basic program that uses Image-Pro to find the worm based on contrast and size (a dark object greater than 700 pixels), and then calculate the worm's centroid on the frame.

I record the motorized stage's position via Stage-Pro [the Image-Pro Plus microscope stage control module - now replaced by the more powerful Scope-Pro], along with the computer's system time. I then get rid of the grabbed image to save memory, storing only the stage, frame coordinates, and the time to a text file. This is done every second to record a time history of the worm's track while it does chemotaxis.



A speed-track of the same worm chemotaxis track.

Submitted by:
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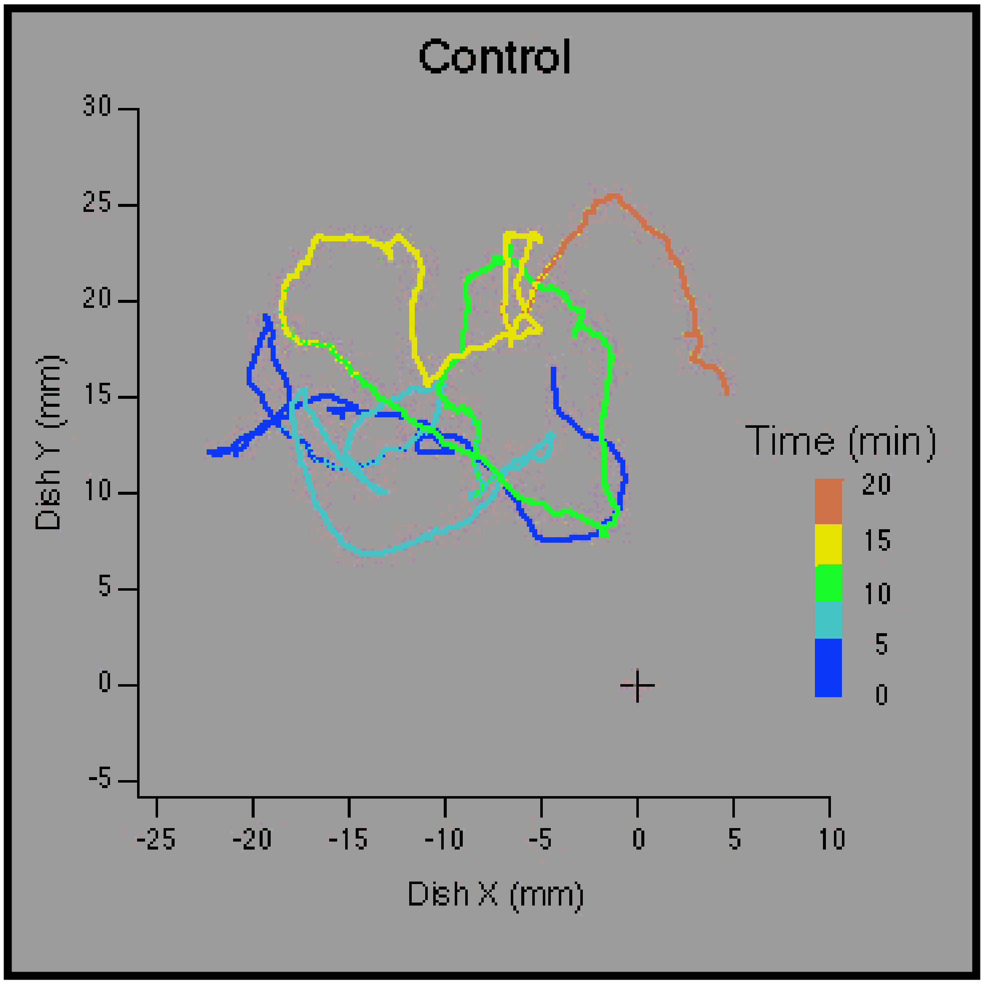
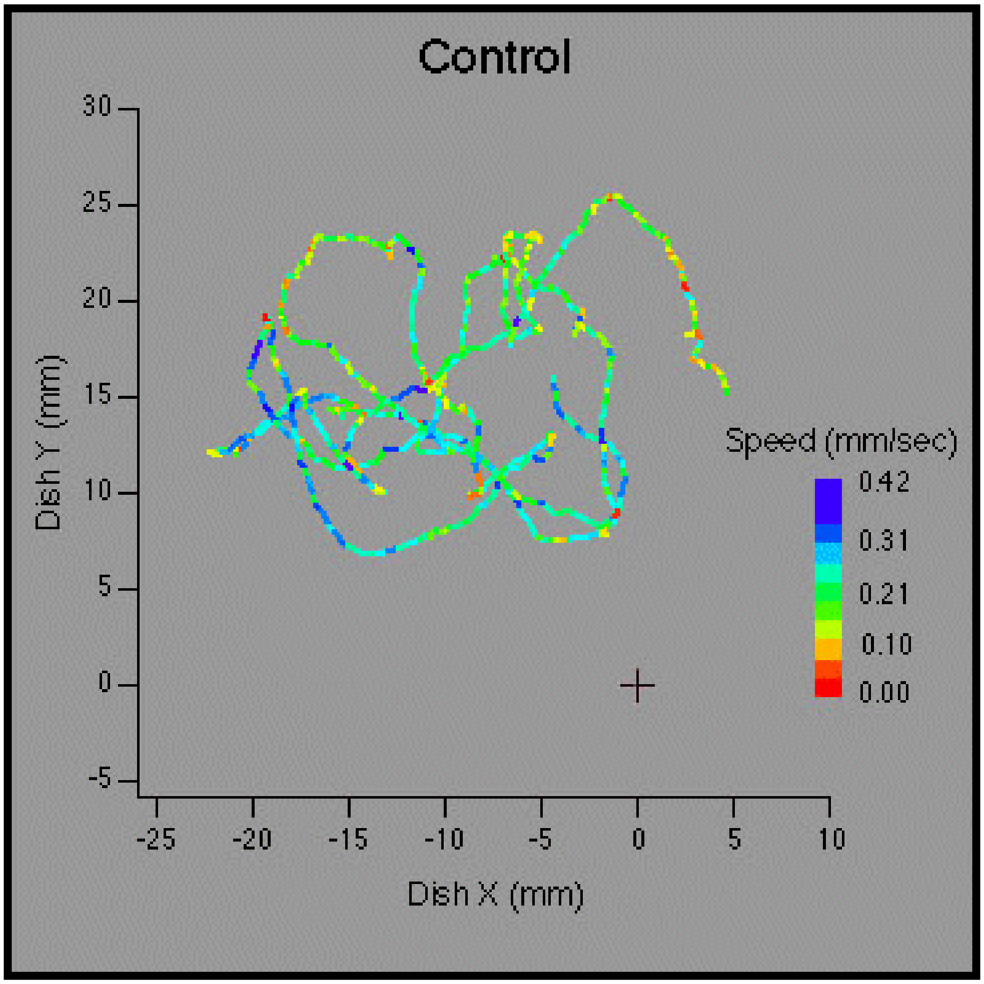


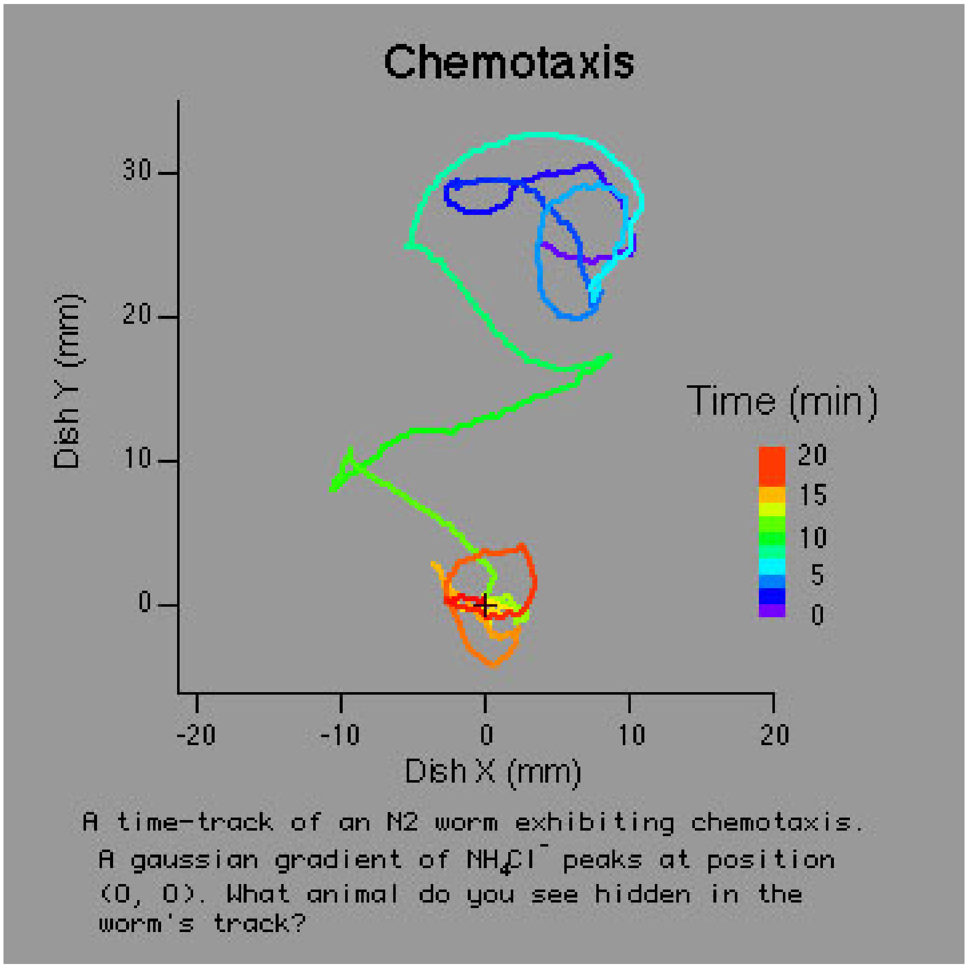
A time-track of typical worm behavior without a gradient.



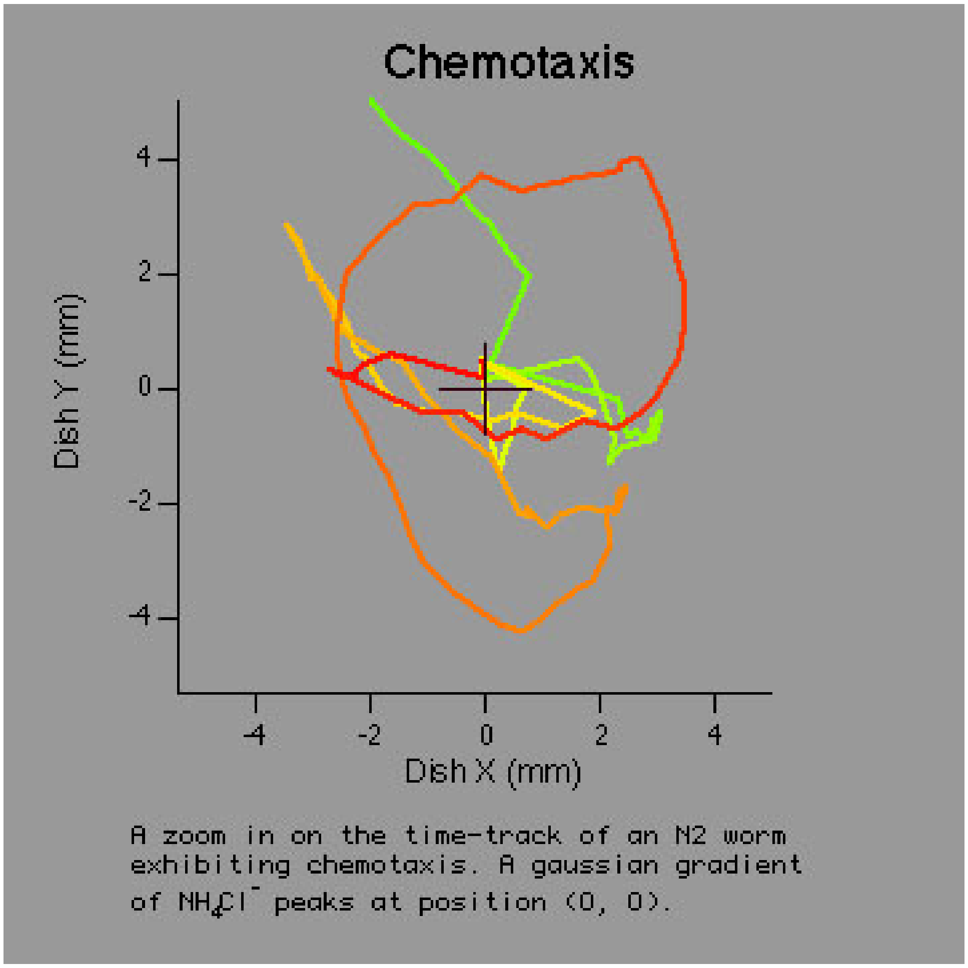
A speed-track of the same control worm track.

Wormtracker Plots

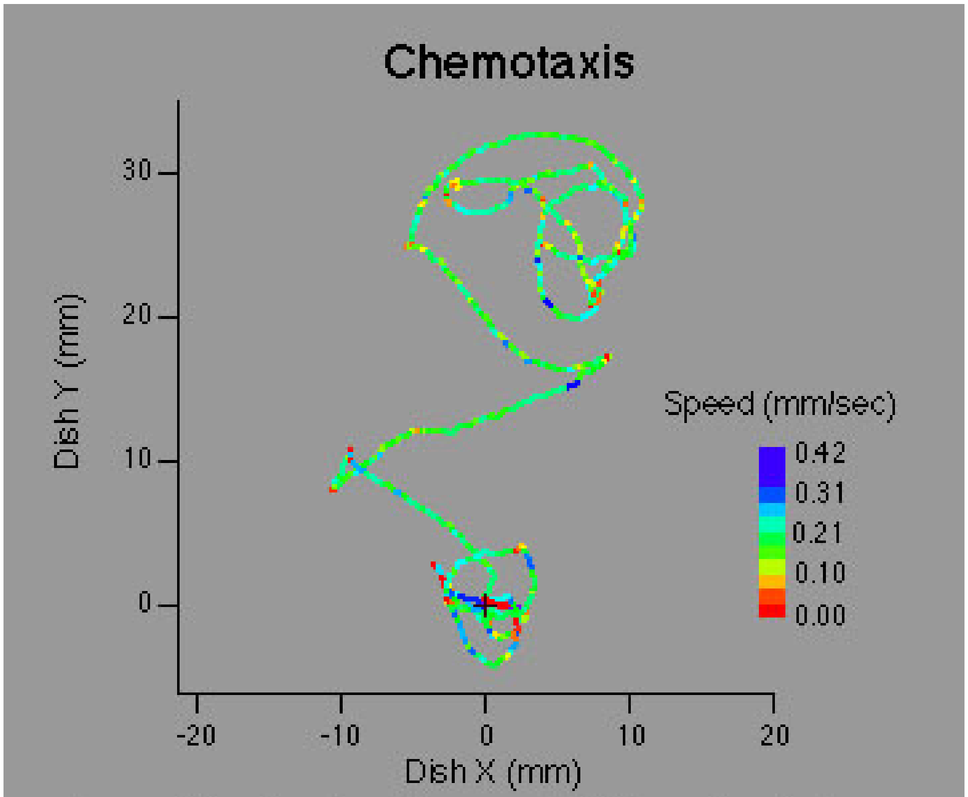
These are brand new pictures generated using the Wormtracker data processed with IGOR Pro version 3.



A time-track of an N2 worm doing chemotaxis in a chloride gradient.

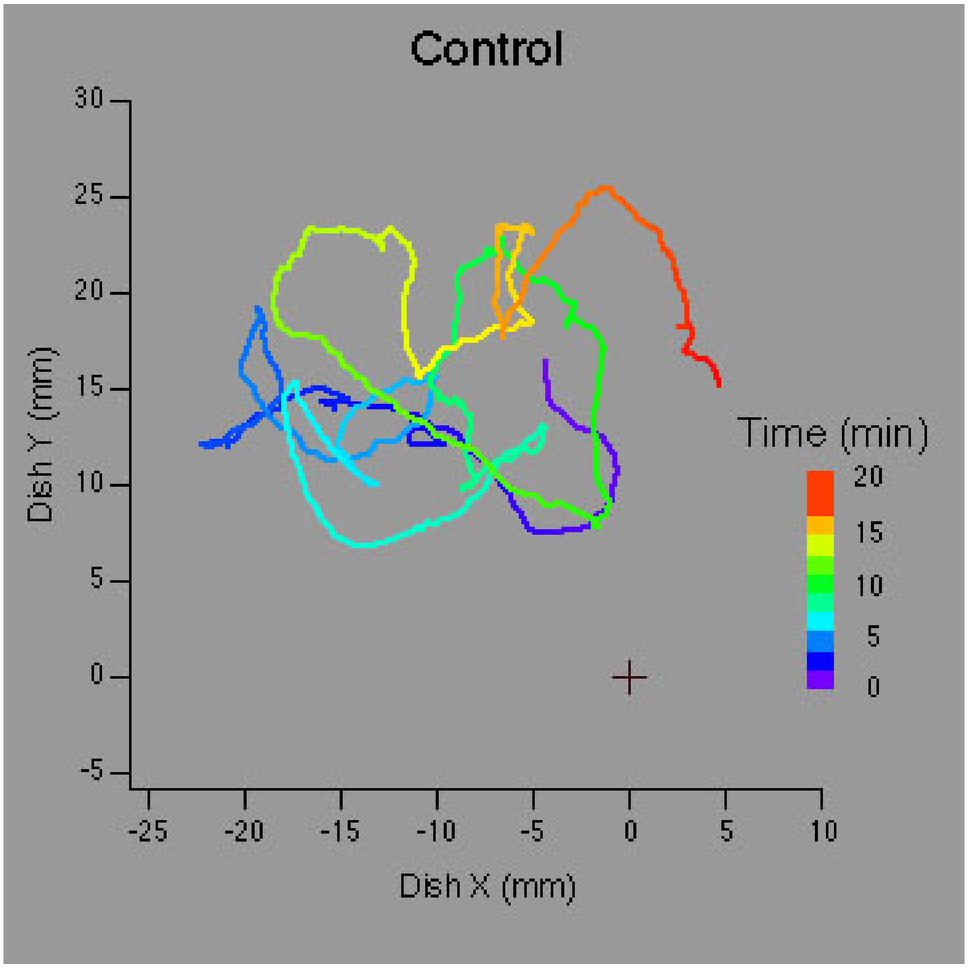


A magnified picture of the same worm track at the center of the gradient.

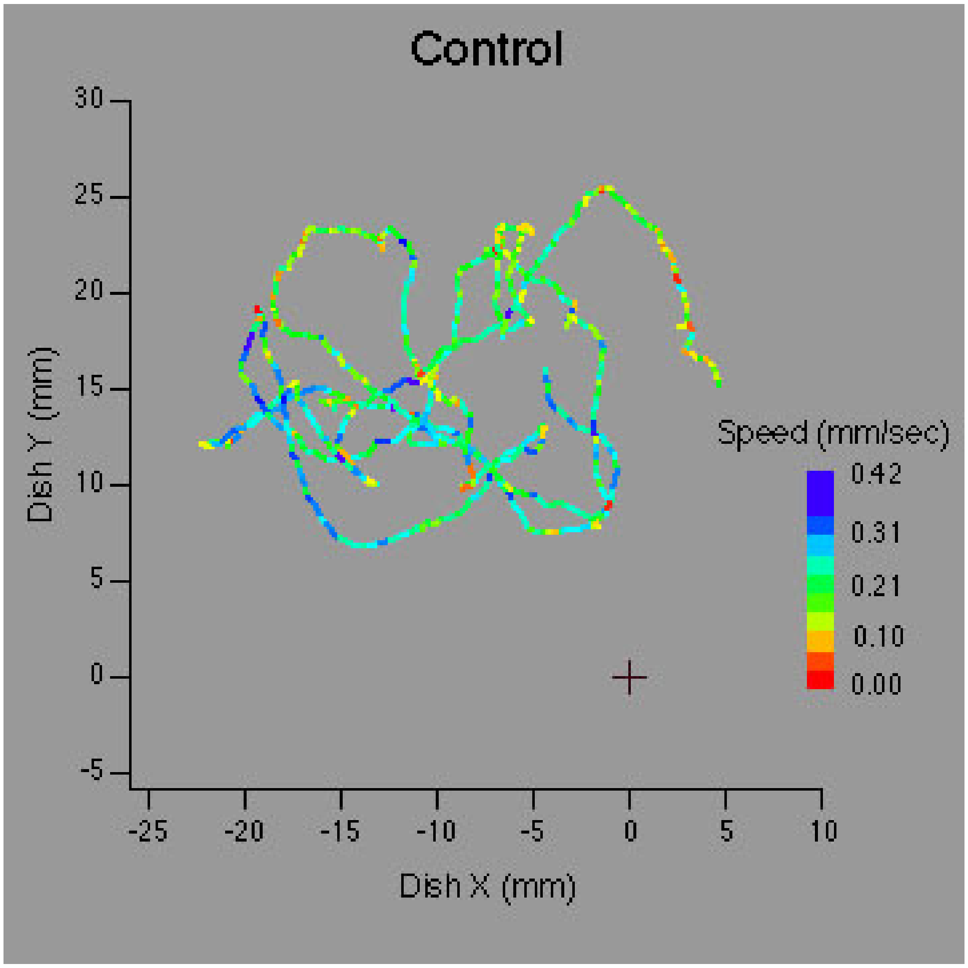


A speed-track of an N2 worm exhibiting chemotaxis. A gaussian gradient of NH_4Cl^- peaks at position (0, 0). Stopped movement is represented red like a stop sign.

A speed-track of the same worm chemotaxis track.



A time-track of typical worm behavior without a gradient.



A speed-track of the same control worm track.

More on worm tracking system (Worm Tracker).

Click on image

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Research Interests

Current research interests combine functional neuroimaging (EEG, MEG, fMRI), signal processing, and computational modeling to study human brain dynamics during visual stimulation and visual attention.

Education

1996 Computational Neuroscience, Marine Biological Laboratory, Woods Hole
1992 Ph.D. in Physics, University of Colorado, Boulder
1986 B.S. in Physics, University of Florida, Gainesville

Appointments

2002-pr Faculty Member, Joint UCSF/UCB Graduate Group in Bioengineering
2001-pr Assistant Professor, Department of Radiology, University of California San Francisco
1998-01 Scientist, Electrical Geodesics, Inc., Riverfront Research Park, Eugene, Oregon
1995-98 Postdoctoral Research Associate, Institute of Neuroscience, University of Oregon
1992-95 Postdoctoral Research Associate, Department of Physics and Astronomy, University of Rochester

1992 Visiting Instructor, Department of Physics, Colorado College

Teaching

Bioengineering 245: Electromagnetic Neuroimaging

Publications

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INQUIRY

Summer 1999

Super-Powerful "Internet of the Future" Will Link Oregon to Computer Innovations

The Abilene Network Makes Today's Information Superhighway Feel Like a Traffic Jam

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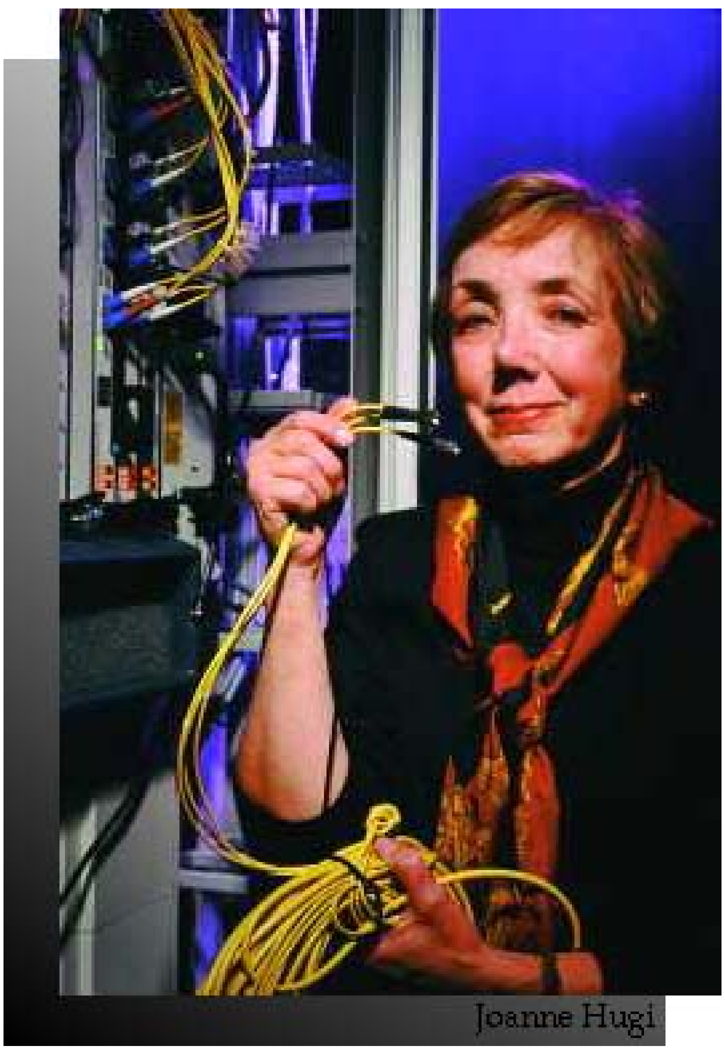


The cable, thick as a pencil and the color of a pumpkin, doesn't look any more heavy-duty than the wire connecting a television and a VCR. But when this particular fiber-optic line was plugged into equipment at the University of Oregon earlier this year, the state of Oregon suddenly had its own "GigaPoP" site. In simple terms, this means that Oregon researchers can now access a new members-only lane on the information superhighway that makes the current Internet feel like a traffic jam.

That lane, a fiber-optic network called Abilene, is the avenue a broad-based scientific effort is roaring down to create the next-generation Internet, or Internet2. More than 150 U.S. research universities–in partnership with industry leaders such as Microsoft, IBM, and Intel and with U.S. federal agencies–are collaborating on the Internet2 project.

"Internet2 is an effort to create the Internet of the future, and Abilene is a vastly important network over which much of that creative effort will flow," says Joanne Hugi, director of the UO Computing Center.

The Oregon GigaPoP consists of two links, one going to Sacramento, California, and the other to

Denver, Colorado. This double connection will serve to protect the system from disruptions that are more likely with a single avenue of access. The two new circuits operate at 155 megabits per second. This is 100 times the speed of the typical T1 connection used by local Internet service providers (ISPs) and thousands of times faster than a standard home modem.

While the Oregon GigaPoP is located in Eugene, the access it provides is not limited to the UO. Scientists at Portland State University, Oregon State University, and other institutions in the state can zoom onto Abilene through the UO connection by way of Oregon's existing high-speed network called OWEN. Using the Owen-to-Abilene connection, Oregon scientists can collaborate with colleagues across the country or link to distant instruments and data. The new connection will provide the link for heretofore-impossible high-performance computing projects. The University of Washington is the only other GigaPoP site in the Pacific Northwest.

"This new network has primarily two functions," Hugi explains. "First, it gives researchers a high-speed proving ground on which to test out the technologies that will dramatically surpass the capabilities of the current Internet."

Many of the technological advances that will someday speed service on commercial Internet service providers–from small, local providers to giants such as America Online–are likely to be developed by academic researchers using Abilene.

"A second important benefit of Abilene is to open the door to university researchers in many fields to access the complementary tools of high-performance computing and advanced networking," Hugi says. "These days high-performance connections are an important tool in a large and rapidly growing number of scientific explorations–in physics, biology, earth science, to name just a few. This tool is taking scientists where their imaginations lead them."

Examples of the uses of Abilene include UO researchers accessing vast data sets from distant particle accelerators, making astronomical observations through telescopes in Arizona or Hawaii, and accessing the country's regional supercomputing centers.

Hugi emphasizes that the connection to the Abilene network means more to the state than just cost-effective access to a superfast network.

"It is vital for the state of Oregon be represented as Internet2 develops," she says. "This project is where the next generation of the Internet will be created, and we want to be a part of that–as large a part as possible. This is a monumental effort, and it is to the state's advantage both educationally and economically to participate in a big way."

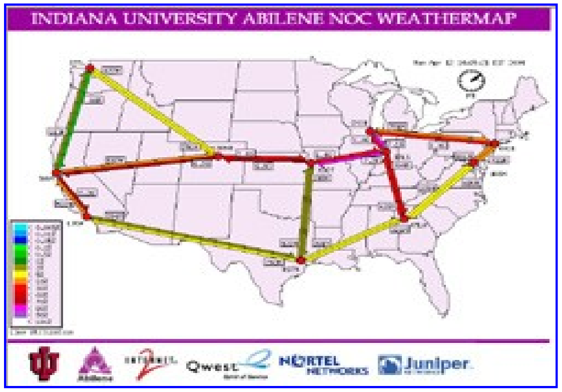
[Back to INQUIRY home page]

Abilene

Advanced networking for leading-edge research and education

ABILENE NETWORK
>About Abilene
>What's New
>Abilene Community
>How to Connect
>Network Operations Center (NOC)
>Maps & Lists
>Peer Networks
>Policies & Operations
>Advanced Services
>Abilene Observatory
>Technology Centers (ITECs)

Abilene Network Map



The Indiana University Abilene Network Operations Center Weathermap shows the current status of the Abilene network at 10Gbps.

Abilene in the News

- Abilene Network Upgrade to 10 Gbps Complete
- Abilene Backbone Network Upgrade Passes Transcontinental Milestone
- First Cross-Country Performance Tests on 10 Gbps Abilene Network

Advanced Networking

Abilene is a proving ground for high-bandwidth technologies. The cross-country backbone is 10 gigabits per second, with the goal of offering 100 megabits per second of connectivity between every Abilene connected desktop.

What's New

- Upgrading Existing Abilene Connections
- Presentations from the Internet2 Spring 2004 Member Meeting
  - Abilene Update (pdf) (video)
- Abilene Network Sponsored Participation Grows to 101 Participants
- Abilene Network Upgrade to 10 Gbps Complete
  - Press Release
  - Map and Information
- Abilene Info Sheet (pdf)
- Abilene Observatory Information Sheet (pdf)

Related Projects

- The QUILT
- Internet2 K20 Initiative
- Internet2 Detective

Are you connected to the Abilene Network?

Try the Internet2 Detective to check Abilene access, available bandwidth, and multicast.

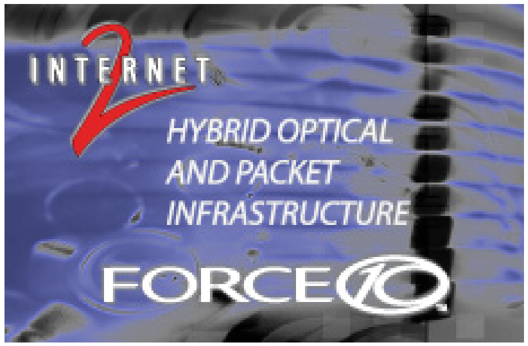
About
- Abilene
- End-to-End PI
- HOPI
- Internet2 Commons
- K20
- Security
- Working Groups
- Related Projects

Members
- University
- Corporate
- Affiliate
- Association

Partnerships
- Government
- International

Events
- Internet2 Events
- Internet2 Days
- Workshops
- Related Events

News
- Newsroom
- Information Kit
- Document Library



With the adoption of network applications that consume multiple-gigabits of bandwidth, the Internet2 community will soon require capabilities beyond those available on its current network infrastructure. To meet the leading-edge networking needs of the research and education community, Internet2 has partnered with Force10 Networks, a pioneer in gigabit and 10 gigabit Ethernet networking, to deploy the company's switch/routers in five nodes of the nationwide Hybrid Optical and Packet Infrastructure (HOPI) testbed. As an Internet2 Corporate Partner, Force10 is providing leadership for the HOPI project, which is developing and testing architectures and technologies that will be the foundation for the Internet2 community's next generation, scalable, high-performance network.

[past showcases]

Spotlight:

Raju Shah is the research and education marketing director at Force10 Networks, where he leads the company's industry group relations. As one of the developers of Force10's flagship 10 Gigabit Ethernet switch/router, Raju has a deep understanding of high-performance networking requirements. Leveraging that expertise as well as earlier network design and management experience at Columbia University and Rutgers, The State University of New Jersey, Raju collaborates with the Internet2 community on the Hybrid Optical and Packet Infrastructure project. Additionally, Raju contributes expertise in support of Scinet, the very high-performance network for the annual International Conference for High Performance Computing and Communications. He also represents Force10 in industry groups such as the Global Grid Forum and the Enterprise Grid Association.

Led by more than 200 U.S. universities, working with industry and government, Internet2 develops and deploys advanced network applications and technologies for research and higher education, accelerating the creation of tomorrow's Internet.

News

28 February 2005

The CampusEAI Consortium and Internet2 Announce The Open Student Television Network

More...

15 February 2005

Internet2 Partners With Force10 Networks For National Deployment Examining High Performance Optical And Packet Architectures

More...

07 February 2005

Internet2 Issues Official Call for Testbed Support Center Services To Operate Its Hybrid Optical and Packet Infrastructure Testbed

More...

Media Clips

Highlights

- Spring 2005 Member Meeting
  - Registration
  - Detailed Program
- Job Opportunities

Events

Internet2 Events

May 2005

Spring 2005 Internet2 Member Meeting

2 - 5 May Arlington, VA

September 2005

Fall 2005 Internet2 Member Meeting

19 - 22 Sep Philadelphia, PA

<past | future>

Internet2 Workshops

March 2005

Internet2 Commons Site Coordinator Training

31 Mar Atlanta, GA

[past spotlights]

02 February 2005

UK schools trial open source access control

Source: *ZDNET UK*

26 January 2005

Internet2 Launches Hybrid Optical and Packet Infrastructure

Initiative

Source: *Converge! Network Digest*

26 January 2005

Testbed To Improve Internet2 Formed

Source: *ExtremeTech.com*

April 2005

Security Professionals Conference 2005

3 - 5 Apr Washington, D.C

4th Annual PKI R&D Workshop

19 - 21 Apr Gaithersburg,

MD

<past | future>

Internet2 Days

Internet2 Day at Notre Dame

7 Apr South Bend, IN

VCU Emerging Technology Day

8 Apr Richmond, VA

New Jersey Institute of Technology Internet2 Day

22 Apr Newark, NJ

<past | future>

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UNIVERSITY OF OREGON

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UNIVERSITY OF OREGON

Oregon Wide Area Network (OWEN)

An Internetwork Architecture for the State of Oregon

A NERO/OSSHE/DAS/OPEN Collaborative Partnership

http://www.antc.uoregon.edu/NERO/OWEN

Working DRAFT
Version 1.2
22 March 1997

David M. Meyer
Advanced Network Technology Center
University of Oregon

Executive Summary

The NERO organization is uniquely suited to provide intra-state transit and Internet connectivity for both the DAS and OPEN networks. NERO currently servers this OSSHE system with a highly reliable, high-bandwidth transport facility and core engineering expertise. Integration of the existing NERO infrastructure with both DAS/ORNET and OPEN offers various economics of scale, including aggregation of intra-state bandwidth demands, transit bandwidth requirements, and engineering

resources. In addition to the obvious benefits that result from aggregation of demand and the sharing of engineering and operational expertise, there are several other benefits that will result from this merger. For example, NERO also offers DAS and OPEN staff access to important emerging technologies, including the various video over IP technologies (MBONE), next generation Internet protocols (IP version 6), and resource reservation (RSVP).

Introduction and Overview

Since early 1994, the State of Oregon, through the Oregon Joint Graduate Schools of Engineering (OJGSE) has invested extensively in high quality intra-institution and Internet connectivity. This connectivity is based on the Network for Engineering and Research in Oregon, or NERO (see http://www.nero.net). The NERO consortium is operated by the Oregon Joint Graduate Schools of Engineering, and currently serves the campuses of the Oregon State System of Higher Education (OSSHE). NERO has been widely recognized as one of the first and most successful ATM WANs (see for example, the Cisco Packet article on NERO), and has been the subject of several technical articles (again, see for example ICC95 or LCN95).

NERO has evolved to provide service to all of the OSSHE campuses, and now consists of ATM, Frame Relay, and leased circuits. In addition, NERO aggregates Internet connectivity for the campuses, with transit connections to both MCI and Northwest Net. In addition, an NSF High Performance Connections 96 (vBNS) grant has been awarded to Oregon State University. The existing NERO connectivity will be used to provide vBNS connectivity for the consortium members.

The remainder of this document is organized as follows: The next section gives a detailed overview of the current NERO architecture. Following sections describe the other networks operated by various *political subdivisions* within the state, and propose an architecture and implementation plan for integrating the existing NERO infrastructure with the State's administrative and K12 networking infrastructures to provide intra-state inter-network connectivity and Internet transit. The final section provides some conclusions.

NERO Backbone Architecture Concepts

The NERO backbone architecture is based on the following four principles:

- ### Backbone Architecture

  NERO is designed to be the backbone for intra-state connectivity. That is, NERO is a network of networks (contrast with a network that directly connects end-users). The NERO core network robustly connects to regional telco transport providers at strategic locations. At the IP level, NERO is designed so that the interconnection of IP networks under varying administrative control is both modular and efficient.

- ## Scalability

NERO is designed to be a scalable backbone for intra-state connectivity, connecting the State of Oregon's organizational networks (examples of organizational networks include the DAS/ ORNET backbone). NERO's backbone architecture provides three main sources of scalability:

  - ### Network Management

  Since NERO is a "network of networks" that connects organizational networks, network management is hierarchical. Network management within each organization scales in the number of network connections it has. The important point here is that the architecture described in this document scales in the number of *organizational connections* to the backbone, and not the number of end sites or users. Examples of *organizational connections* include the single connection to the DAS/ORNET network proposed here. Note that it may be desirable for an organization to have two connections for redundancy, but this must be balanced against cost and the greatly increased the complexity of management and engineering.

  - ### Internal Bandwidth

  NERO is uniquely situated to provide highly aggregated, high quality intra-state data transport. This aggregation is achieved by a combination *statistical multiplexing* and engineered bandwidth. Statistical multiplexing is the fundamental principle underlying the design of almost every networking structure (including very large networks such as the public switched phone system). Briefly, the concept behind statistical multiplexing is that the natural distribution of traffic flows in a packet network allows for bursts (brief periods of high traffic) from any source that is equal to the underlying capacity of the network. A corollary of this result is that statistical multiplexing also provides efficient sharing of bandwidth between multiple sources [KLEINROCK].

  - ### External Bandwidth

  As is the case for intra-state bandwidth, combination of hight bandwidth (DS3 and above), multiple paths, and statistical multiplexing also allows the NERO fabric to efficiently aggregate traffic for either transit ("Internet") or peerage (other Internet-like connections to service provider backbones). Please see the discussion of Transit versus Peerage for more details.

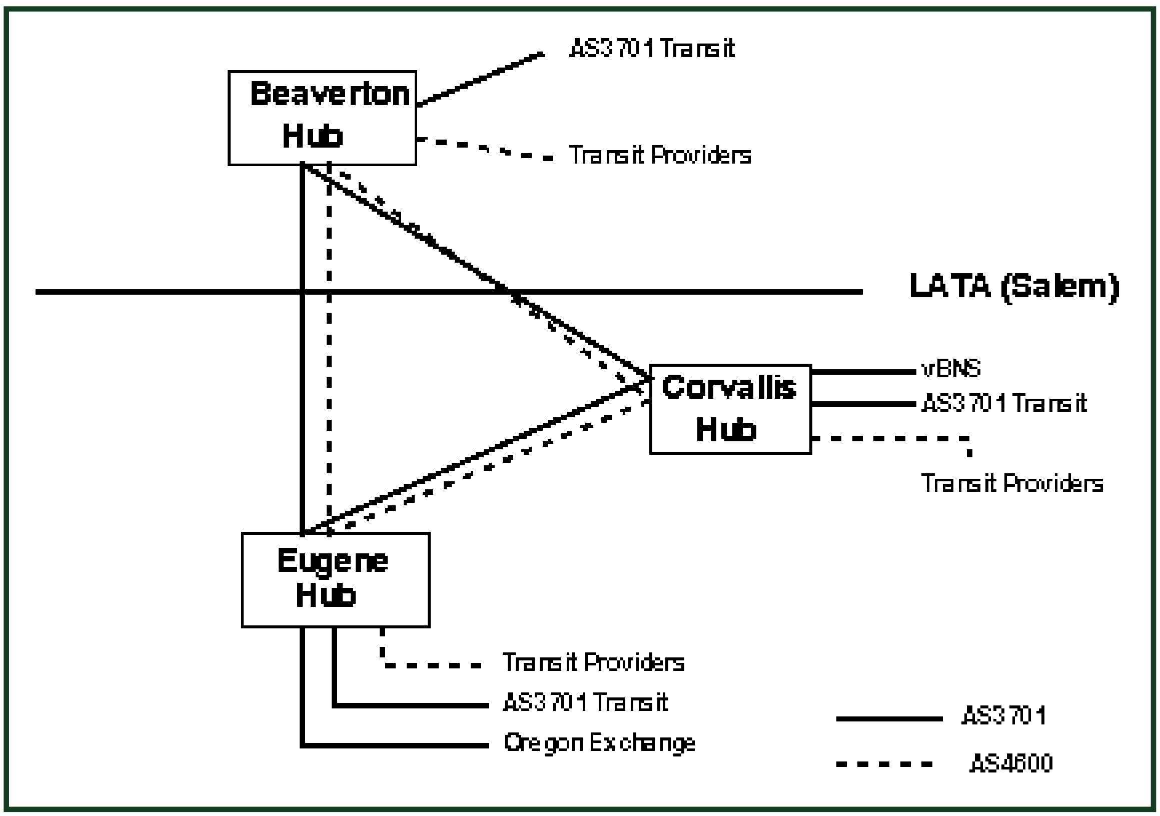
- ## High Availability

The NERO architecture is designed to have *Order 4* reliability. This means that the network is designed for uptime of at least 99.9999%. Of course, this requires not only robust infrastructure but proactive network operations.

- **High Performance**

  NERO is designed to provide two orders of magnitude greater intra-state bandwidth. In addition, the NERO design incorporates external ("Internet") bandwidth that is an order of magnitude greater that what is commonly available.

These goals are realized by providing path, switch, and route *diversity* . A path diverse network will have more than one path to any location (usually so that any single failure does not partition the network). A switch diverse network will have different switching equipment along the different paths. Finally, a route diverse network has more than one source of external routing information (usually meaning the routing domain is multi-homed). Note that path and switch diversity refer to the physical or transport facilities, while route diversity refers to the Internet Protocol level. The NERO architecture is designed to be path, switch, and route diverse.



The figure above is a schematic of the NERO WAN. This figure includes only the backbone circuits. The boxes represent NERO Hubs , which are described below. In the diagram, "Transit Providers" represent Internet transit providers, and "AS3701 Transit" are connections to networks that don't provide Internet transit (or peers; see the Transit versus Peerage discussion below).

Note that the architecture is path diverse, since no single circuit failure will partition the network (there is also a backup T1 infrastructure that mirrors the high speed infrastructure; this is not shown in the figure). In addition, since the hub site design has local CPE, the network is switch diverse. That is, no two sites use common switching equipment.

The intra-hub transport is provided by running ATM over SONET in the Corvallis to Eugene path, and by running ATM over DS3 in the cross-lata paths. NERO owns it's on ATM CPE, so no provider cloud is used to provide core backbone connectivity. This provides improved flexibility and managability in the core of the network.

Note: The cross-lata transport in not currently actually path diverse, since the connections between the Corvallis HUB and the Beaverton HUB, and the connections between the Eugene HUB and the Beaverton HUB ride on the same telco facilities.

Transit versus Peerage

Before discussing route diversity, two important concepts must be understood. The first, *peerage* , refers to a relationship, usually between two network service providers (a "bilateral" agreement), in which the providers agree to accept each other's customers traffic. In practice, this means that when providers **A** and **B** agree to *peer*, **A** will send **B** traffic from its customers destined for **B's** customers. Conversely, only traffic destined for **A's** customers will traverse the link from **B** to **A** . *Transit* , on the other hand, refers to a relationship, again, usually between a network service provider and a customer, in which the provider will pass the customer's traffic not only to the providers other customers (e.g., peering), but also beyond to the provider's peers (hence the term "transit"). Transit is what is commonly though of as "Internet Connectivity". The reader is encouraged to see [HUSTON94] and [HUSTON92] for execellent overviews of Internet connectivity models.

NERO Route Diversity

NERO route diversity is achieved by a two-fold strategy. First, NERO has multiple transit providers. NERO currently receives transit from MCI and Northwest Net, with additional transit providers are planned. Second, NERO peers with many other providers at the Oregon Exchange (see http://www.antc.uoregon.edu) . Thus NERO achieves route diversity by transit connections to MCI in Eugene and and Northwest Net) in Beaverton, and via bilateral peering agreements at the Oregon Exchange. Finally, special connectivity projects such as the vBNS provide another, although more restricted form of route diversity.

Connecting to the NERO Backbone

In the figure above, each hub site has a set of connections labeled "AS3701 Transit". These represent attachments to various transit provider clouds (e.g., ATM or Frame Relay). Sites that connect to the NERO backbone via the AS3701 Transit transport are called "peer networks". Peer networks may receive either or both of the following services:

- ### Peerage

  NERO or the peer wants access the resources of the peer network. These peer networks do not receive transit from NERO. Examples of this include WNA, Structured Networks, and (currently) the State of Oregon. The objective of this peerage is to maintain traffic locality where possible. Note that this locality results in (i). improved performance to those peer sites, and (ii). reduced traffic traversing expensive transit links; traffic to peer networks travels over the peering.

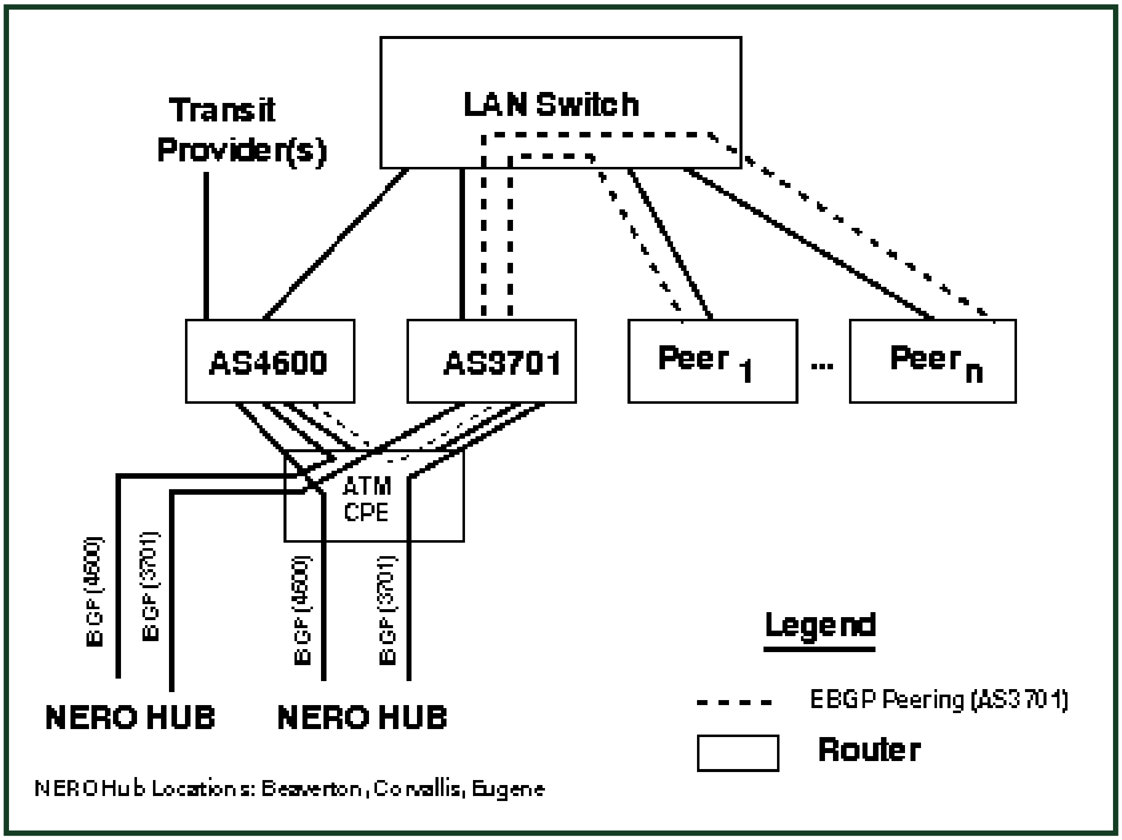
- ### Transit

  The peer network wants peerage, but also requires transit services. The current sites receiving transit from AS3701 are the NERO campuses. An example of this is the OSU campus, which receives transit by peering with AS3701 at the Corvallis Hub. In practice, this means that NERO passes routing information and traffic to and from OSU to the Internet Service Providers from whom NERO purchases Internet Transit.

The connections labeled "Transit Providers" in the figure refer to connections to Internet Service Providers from whom NERO has purchased Internet transit. As mentioned above, NERO currently has transit relationships with MCI (at the Eugene HUB) and Northwest Net (at the Beaverton Hub). Finally, there are several other peer connections, either to the vBNS (via the Corvallis Hub), or to various providers across the Oregon Exchange (via the Eugene Hub).

The basic model, then, is that the NERO backbone is comprised of dedicated, point-to-point circuits designed to provide path, switch, and route diversity. Transport provider clouds (e.g., ATM or Frame Relay Clouds) connect to be backbone at the Hub sites. This provides flexible attachment points at various locations around the state. In addition, a peer network is immediately able to take advantage of the various NERO connectivity sources without having to understand or negotiate those arrangements for itself.

NERO Hub Architecture



The figure above shows the structure of a generic NERO Backbone HUB (also called a POP, or point of presence). The NERO Backbone HUBs are located in Beaverton, Corvallis, and Eugene. Each HUB site is physically secure, and has an appropriately conditioned environment.

A HUB typically consists of two core routers, an ATM switch, and a LAN switch. The routers (labeled AS4600 and AS3701 in the figure) implement various peering and transit policies. The ATM switch is used to connect to the ATM fabric. Finally, the LAN switch is present in order to connect other networks that have independent internal administrative structure. The boxes labeled **Peer** represent peer networks that receive either peerage or transit from NERO. Note, however, that a peer network need not co-locate with the NERO HUB site. The connection can be established over a transport provider facility (e.g., Frame Relay). As mentioned above, the NERO HUB contains two core routers, one labeled AS4600 and one labeled AS3701. These numbers refer to the *autonomous system* number (or ASN) used by the BGP-4 routing protocol. External (transit) providers connect to AS4600. Other, non-transit providers (e.g., OSU) connect to AS3701. This separation provides increased flexibility and administrative control.

Political Subdivision Networking

The State of Oregon is administratively organized into political subdivisions . This discussion focuses on the telecommunications technology missions of the Oregon Department of Administrative Services and the Oregon Public Education Network Consortium.

- **Department of Administrative Services (DAS)**

  The Oregon Department of Administrative Services, or DAS provides an extensive set of network transport and applications services to the State Administrative Offices . Please see http://telecom.das.state.or.us/ for further details.

- **Oregon Public Education Network (OPEN)**

  The Oregon Public Education Network, or OPEN provides network services to the K-12 community in Oregon. OPEN was conceived in the early 1990's by several Educational School Districts (ESDs) that recognized the difficulty in providing essential network services to K-12 in the State. OPEN is a collaborative between the Oregon Association of Education Service Districts, the Oregon Department of Education and the Department of Administrative Services. Please see http://www.open.k12.or.us/ for additional information.

An Integrated Architecture

- **Objective**

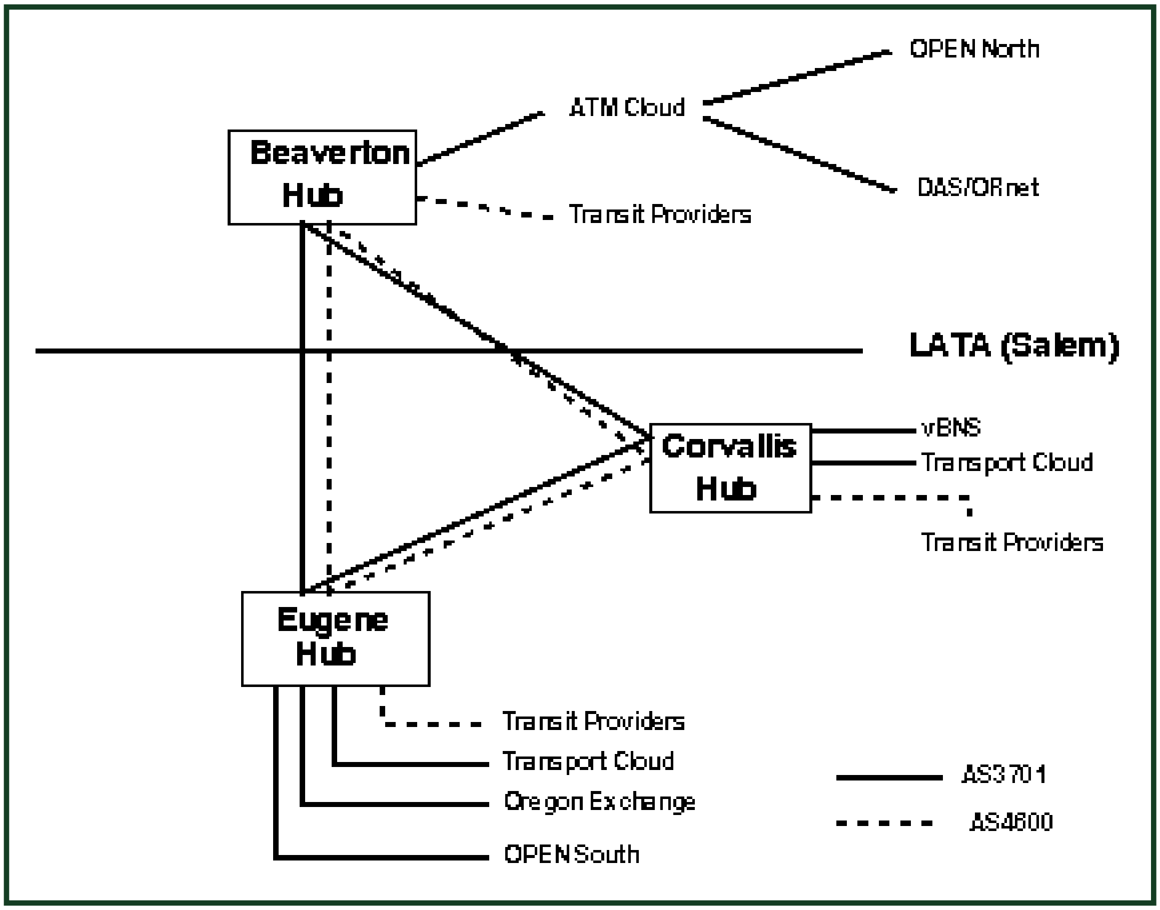
  This document will focus on attachment of the DAS/ORNET and OPEN networks to the NERO backbone intra-state inter-network connectivity and for Internet transit. It is not envisioned that NERO will engineer or operate internal DAS/ORNET or OPEN networks (architecturally, this separation is accomplished by having separate *autonomous system* numbers). It is envisioned, however, that NERO will be a technical resource for engineering and operational issues (continuing the highly cooperative environment that now exists).

- **Model**

  As described above, the NERO architecture has been designed so that other peer networks can easily be attached. The only requirements are that the peer network be able to reach a NERO HUB over some provider transport cloud (such as ATM or Frame Relay), and that the peer network be able to exchange routing information using BGP-4.

- **Integrated Architecture**

  The following diagram describes the plan for integration of both the DAS/ORNET and OPEN networks into the NERO backbone.



In summary, it is recommended that DAS/ORNET provision a single connection to NERO backbone, terminating at the NERO Beaverton HUB. It is recommended that OPEN also provision a connection to NERO backbone terminating at the NERO Beaverton HUB, and that the OPEN South HUB connect at the NERO Eugene HUB (note that the OPEN North and South hubs do not otherwise interconnect).

Implementation Plan

- **DAS/ORNET**

  It is assumed that DAS/ORNET internally connects political subdivisions within the State (with the exception of the OSSHE System and the OPEN project), and so will have a single point of attachment to the NERO backbone. It is recommended that this connection be a single ATM PVC from its Salem location to the NERO Beaverton HUB. Note that when this connectivity is established, DAS/ORNET can shut down it's peer on the Oregon Exchange.

  - **Resource Requirements**

    - **Circuit Charges**

DAS/ORNET will need to purchase ATM service from USWEST. NERO staff will assist DAS/ORNET in specifying the details of the required service.

- **Hardware**

  DAS/ORNET will need to obtain a Cisco AIP (ATM interface card) or equivalent. Of course, DAS/ORNET will also need a slot in a core (Cisco) router for the ATM interface. NERO staff will assist DAS staff in specifying, installing, and configuring the ATM interface.

- **Fallback Position**

  DAS/ORNET currently has a T1 frame relay circuit (and a router) co-located on the Oregon Exchange. This circuit can be rehomed onto a NERO Hub router to provide transit (while maintaining the same peerage) until the new facilities are in place. This can be accomplished immediately.

- **IP Topology**

  DAS/ORNET will exchange routing information via BGP-4 to AS3701 at the Beaverton Hub. NERO will agree to advertise DAS/ORNET routes to all peers and transit providers. NERO staff will assist DAS/ORNET in configuring the BGP session.

- **OPEN**

Like DAS/ORNET, it is assumed that OPEN will represent it's political subdivision and have a single point of attachment to the NERO backbone. It is recommended that OPEN purchase a single ATM PVC from the OPEN Hub (located at th Clackamas ESD) to the NERO Beaverton HUB.

- **Resource Requirements**

  - **Circuit Charges**

    OPEN will need to purchase ATM service from USWEST. NERO staff will assist OPEN in specifying the details of the required service.

  - **Hardware**

    OPEN will need to obtain a Cisco AIP (ATM interface card), or equivalent. Again, OPEN will also need a slot in a core (Cisco) router for the ATM interface. NERO staff will assist OPEN staff in specifying, installing, and configuring the ATM interface.

- **Fallback Position**

  Interim connectivity can be established using T1 frame relay. This connectivity can terminate at any NERO HUB. However, since OPEN seeks greater than one T1 of aggregate transit bandwidth, this approach is not recommended.

- **IP Topology**

  OPEN will exchange routing information via BGP-4 to AS3701 at the Beaverton Hub. NERO will agree to advertise OPEN routes to all peers and transit providers. NERO staff will assist OPEN in configuring the BGP session.

Conclusions

Integration of the existing NERO infrastructure with both DAS/ORNET and OPEN offers various economics of scale, including aggregation of intra-state bandwidth demands, transit bandwidth requirements, and engineering resources. Because NERO was designed for this purpose, integration and provision of IP services to new networks is natural. It is the goal of this proposal is to show how the reliable, production quality utility that NERO provides to the OSSHE system can be naturally and easily extended to both DAS and OPEN.

Finally, it is important to note that in addition to the obvious benefits that result from aggregation of demand and the sharing of engineering and operational expertise, there are several other benefits that will result from this merger. For example, NERO also offers DAS and OPEN staff access to important emerging technologies, including the MBONE, IP version 6, and resource reservation (RSVP).

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INQUIRY

Summer 1999

The Tools of the Trade

Fine Arts Students Going Digital, Using Computers as Creative Tools

---

During the 22 years between the first and latest *Star Wars* films, digital technology has shifted into hyperdrive. Consider the spectacularly rapid evolution of the personal computer, the Internet, and the computer-generated special effects with which George Lucas and company will wow audiences this summer.

Ying Tan

Twenty-two years is also the age of some students in Associate Professor Ying Tan's 3-D animation class at the University of Oregon.

"These students have grown up along with computer-generated 3-D graphics in video games, movies, and television. They are very interested in learning how to use these remarkably powerful new tools," says Tan, who teaches in the UO Department of Fine and Applied Arts.

Tan spent much of 1996, her first year at the UO, responding to this growing student interest by developing a new and expanded 3-D design curriculum for the department's visual design major. The next fall she began teaching a year-long course sequence in which her students learned to master a powerful software program called "3-D Studio Max." The program is sophisticated enough to make highly complex and realistic 3-D computer models, environments, and lifelike character animations. It helped create special effects for the motion picture *Lost in Space*, and the television series *Ally McBeal*, as well as a number of popular video games.

."The Studio Max program is quite challenging. It takes one term to learn some of the basics and a year to become fairly skilled with its more advanced animation features," she explains.

.But powerful software such as 3-D Studio Max requires brawny hardware–more brawny than the machines Tan had at her disposal.

."My students had to use an all-purpose university computer lab, which offered very limited access time," she says.

.So Tan, along with several other faculty members and university administrators, sought out and secured a gift from Intel Corporation of approximately $300,000 worth of computer equipment. The 24 Pentium II computers that made up the first installment of the gift established the new Architecture and Allied Arts Multimedia Lab, where Tan's students now have 24-hour access to the graphics systems they need. A second gift installment of still more advanced Pentium III computers will arrive from Intel later this year.

."This gift from Intel is of great use to UO students as they work to acquire advanced technical skills and use this technology in the creative arts," says Robert Melnick, dean of the School of Architecture and Allied Arts.

."The applications of 3-D technology are growing very rapidly in many fields. In education virtual-reality environments are making the learning experience more immediate, more direct and more like real life," Tan says.

.One of Tan's own projects points up the usefulness of 3-D graphic work. She contributed to the award-winning series of medical videos titled *A Time of Diagnosis* that explain to patients the nature of their illnesses and the treatments used in response.

.Tan notes that 3-D graphic technology is being applied in a number of other areas as well: film production, fine arts, previsualization of product or architectural design, scientific visualization, video games, even medical applications such as the training of surgeons.

."As each of these areas of application develop, there will be an increasing need for artists with the skills to create 3-D graphics," she says.

Many of Tan's students have landed jobs–some while still students–at Dynamix Inc., a video game maker located in the Riverfront Research Park adjacent to the UO campus. In another partnership between the university and industry, Dynamix has agreed to keep Tan's 3-D animation courses supplied with the latest software for two years.

"This technology is an extremely productive area of human endeavor and one in which we are working very hard to stay in the vanguard," she says. "My students are benefiting from and participating in this exciting period. My hope is that with the tools they gain here at the UO they will be more empowered to contribute their creativity to society."

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YING TAN : digital media designer / associate professor @ university of oregon

e a s t e r n [origin] w e s t e r n [experience]

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Christine Sundt Invited to Serve on the Grove Art Advisory Board

Christine Sundt, Visual Resources Curator at the University of Oregon, has been invited to serve on the Grove Art Advisory Board.

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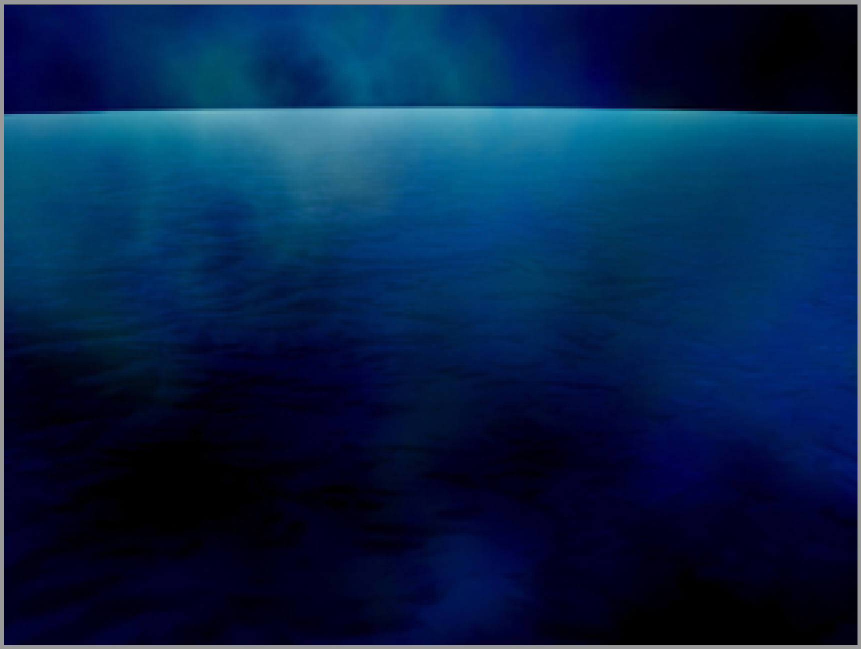
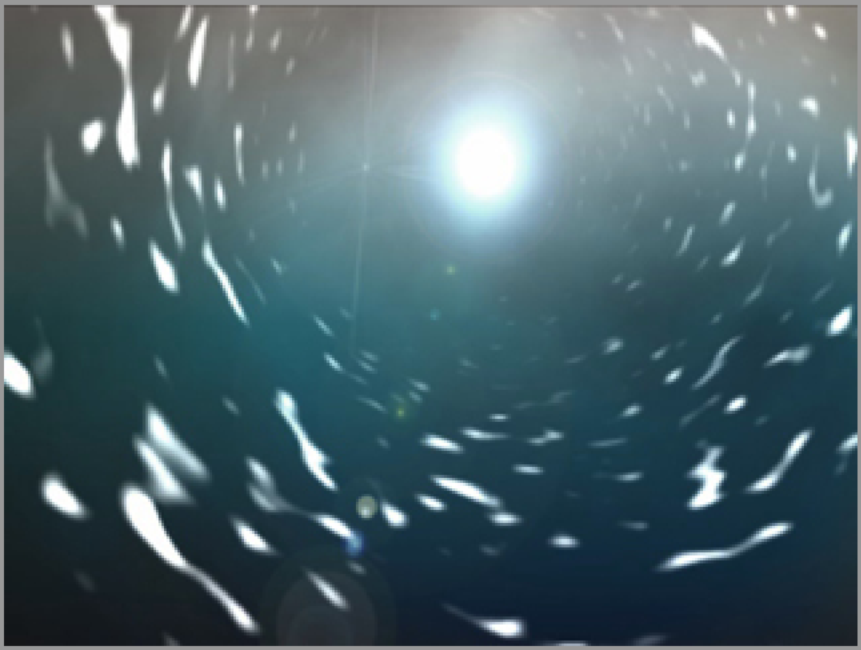
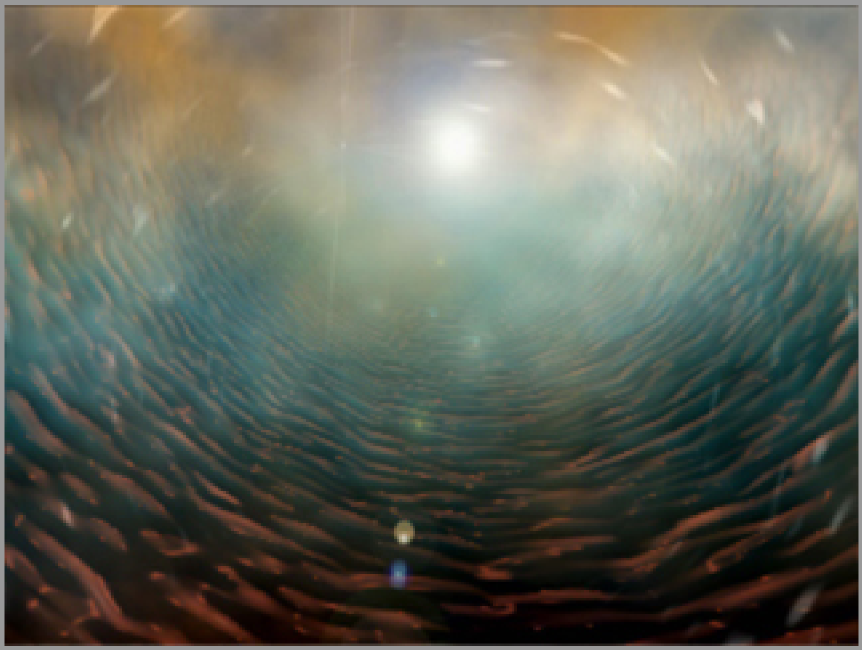
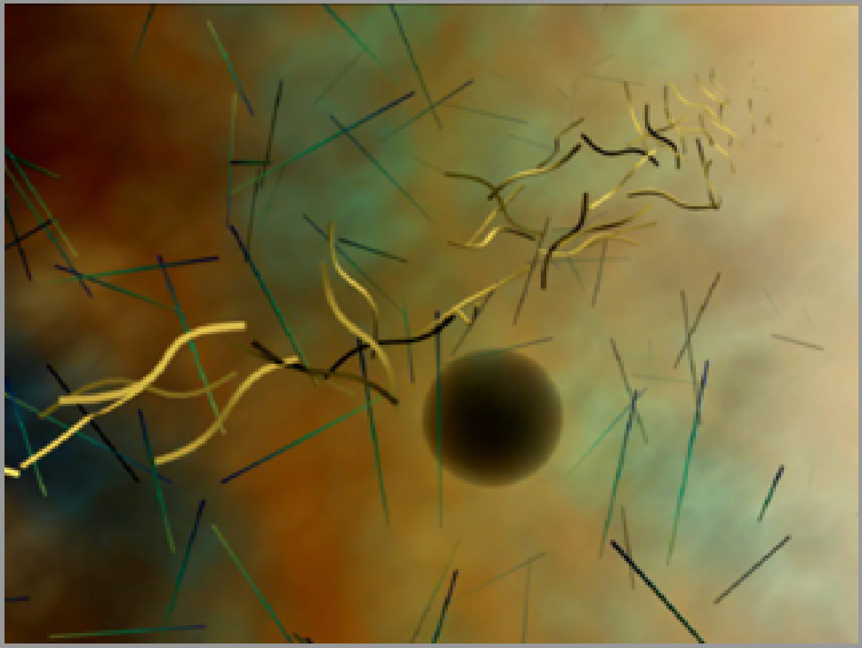
Recent Creative Work / FILM

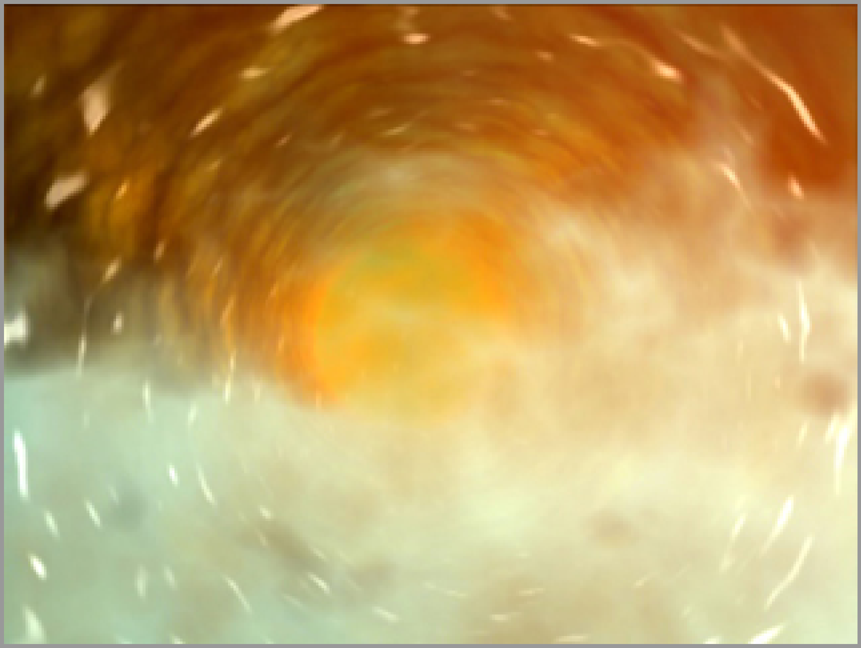
Images from short film "un albor (DAWN)", 1999

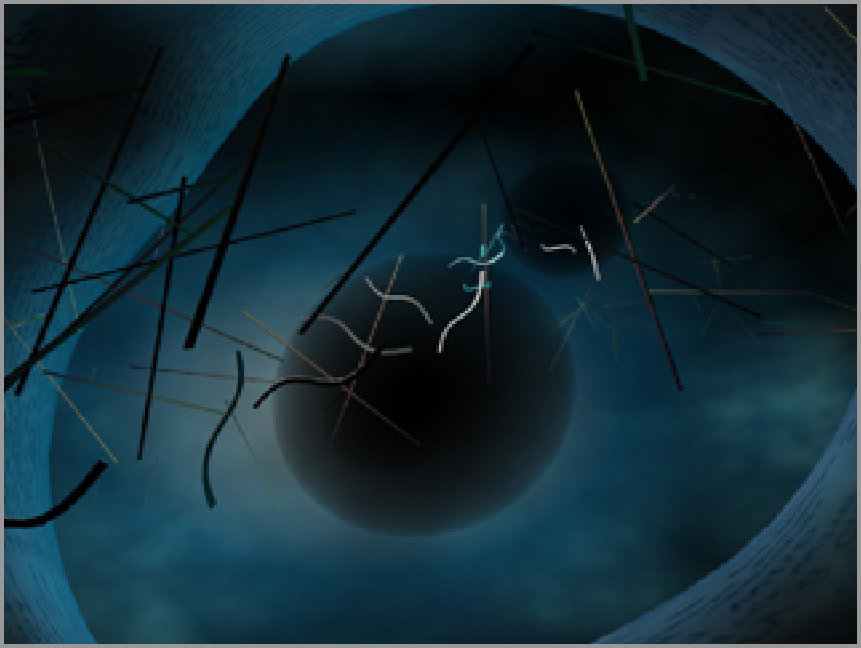




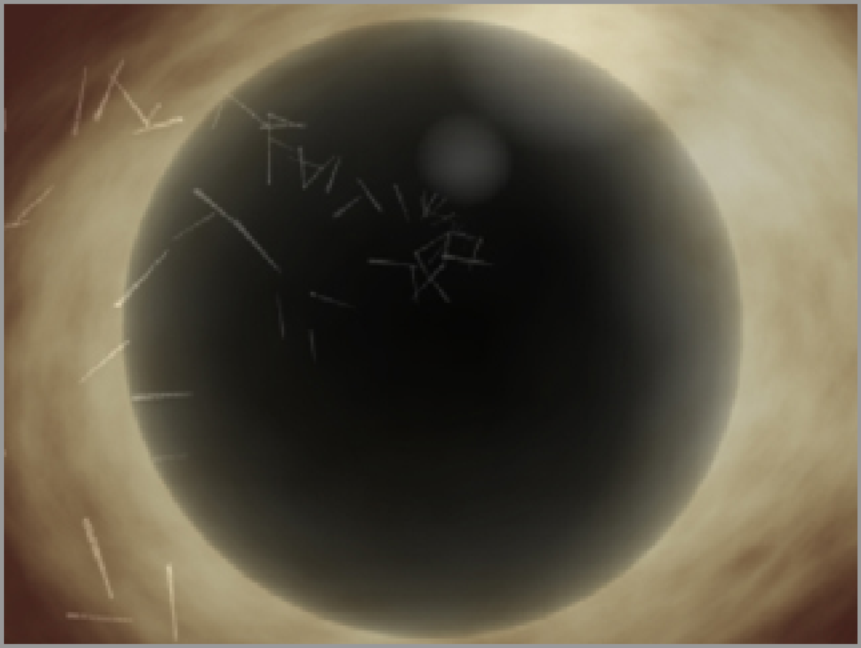


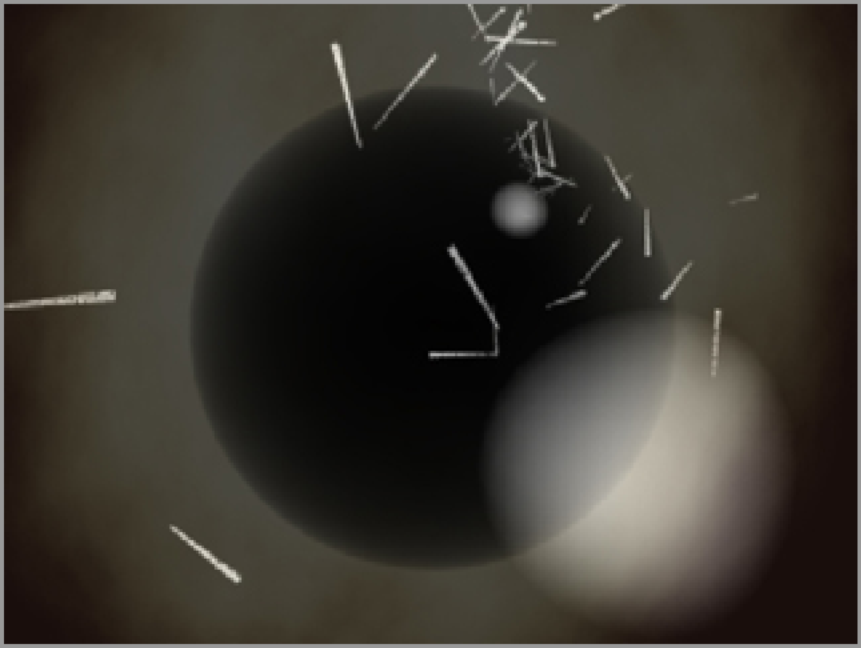


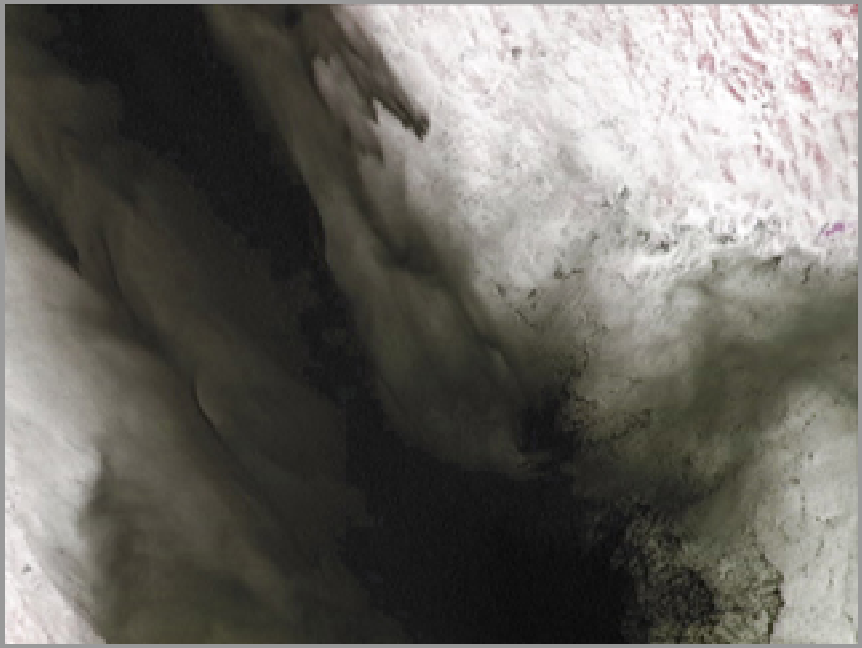


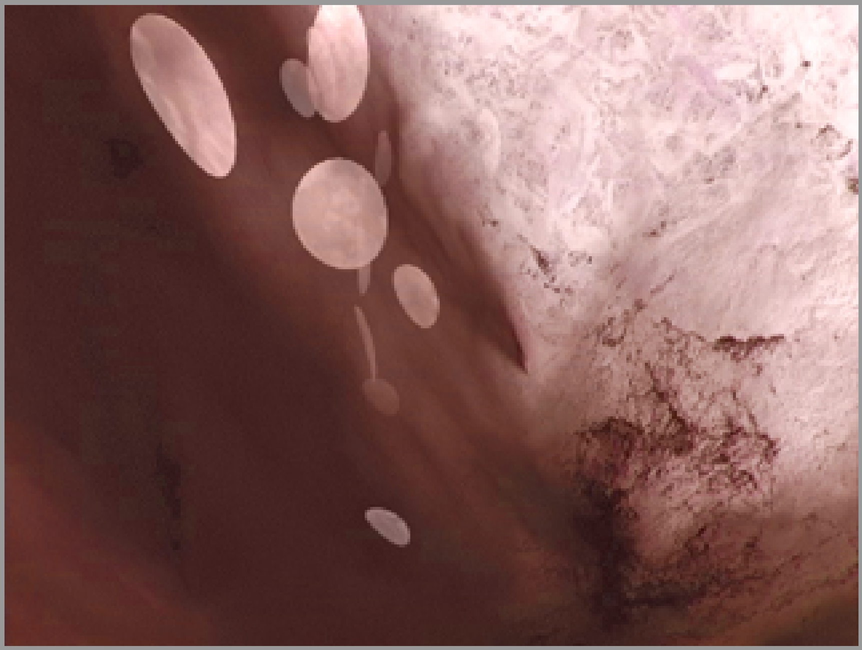


Images from short film "mi vida (MY LIFE)", 1999

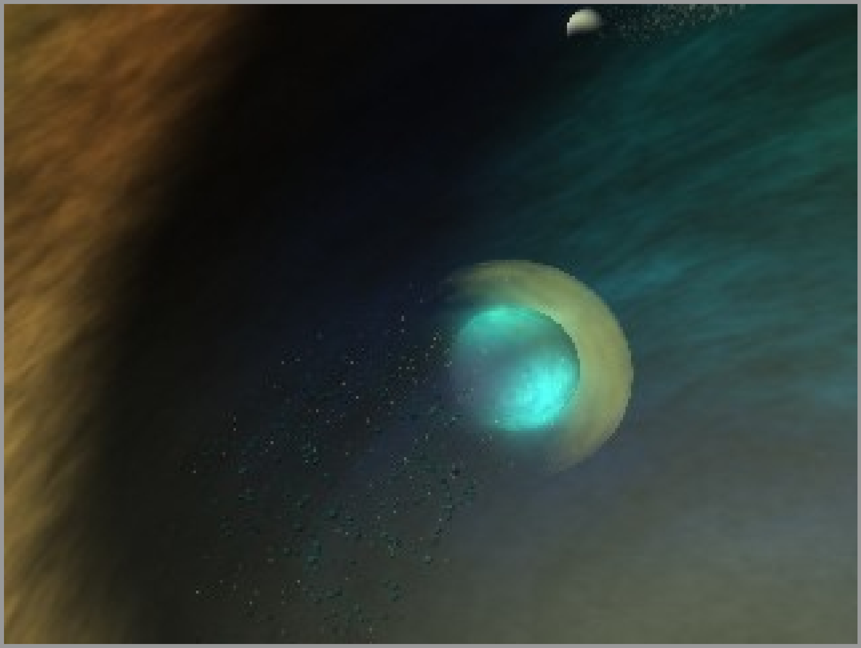


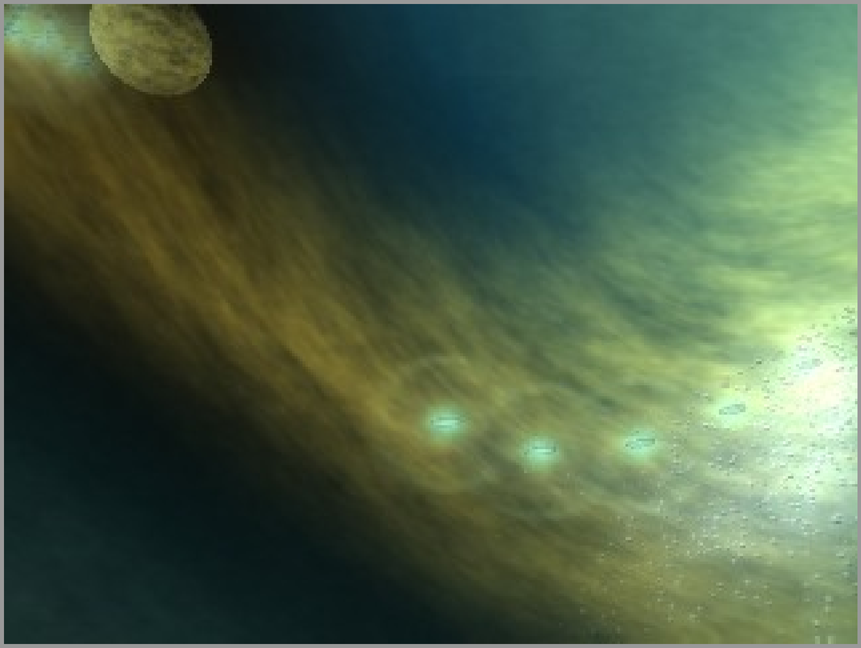


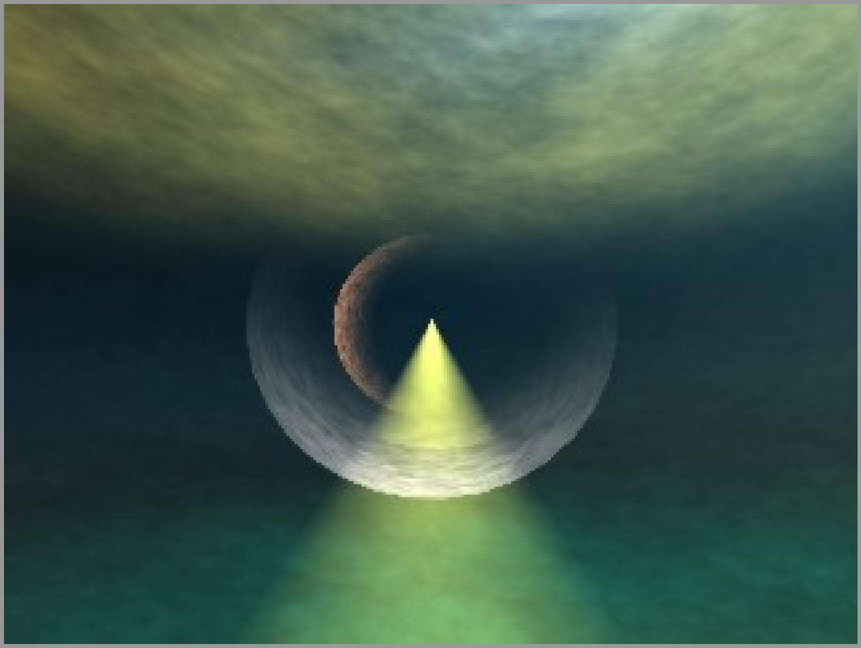




Images from animation "Elements in Transformation", 1998







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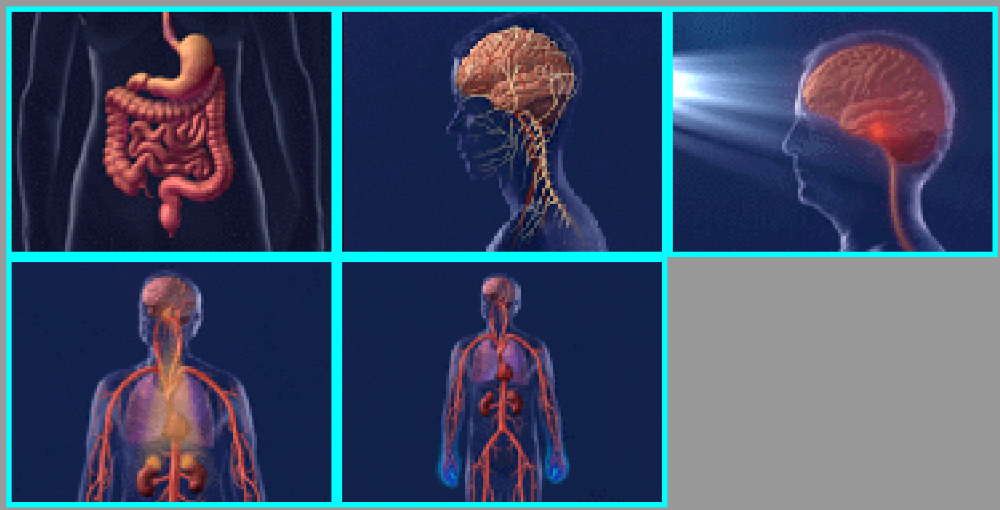
w e s t e r n experience

3D Computer Animation Production



Alias animation for TimeLife Medical's video series "at Time of Diagnosis". This project won Frank H. Natter Award in 1995

Alias animation for "vision to reality",1996
Click to see the animation clip.

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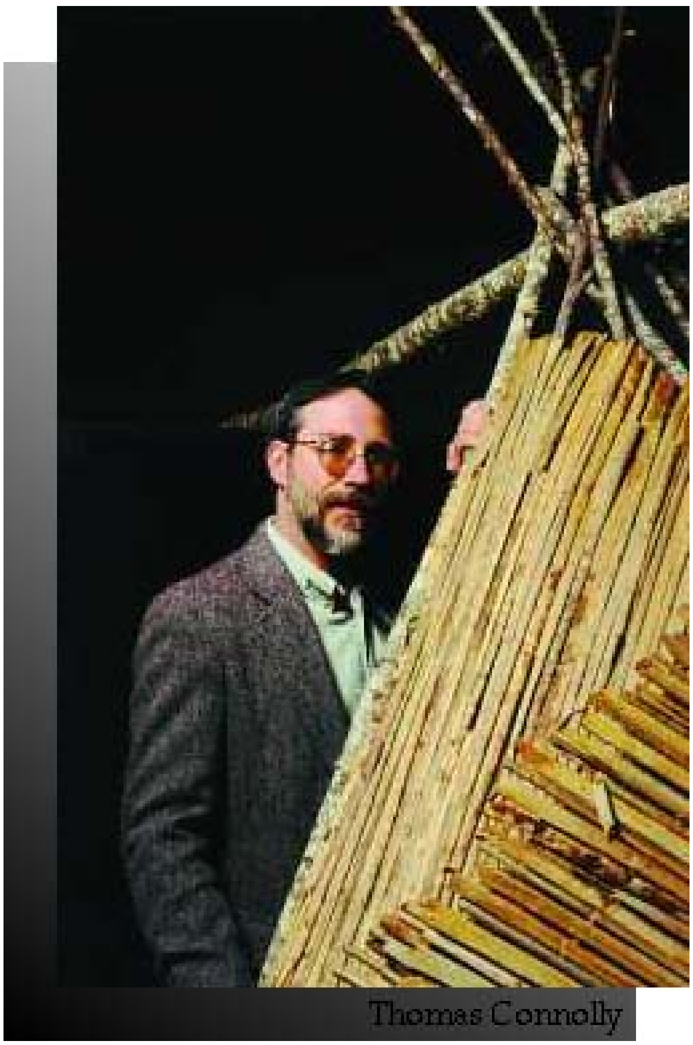
INQUIRY

Summer 1999

One Room, Lakeside View

Scientists Uncover Oldest House in North America Near Bend



Thomas Connolly

.Our understanding of the early native inhabitants of the New World–and Oregon in particular–has leapt forward with the discovery by University of Oregon archaeologists of the oldest house in North America.

.The researchers discovered the remnants in central Oregon, on the shores of Paulina Lake within the Newberry volcanic caldera. The ancient home site contains structural posts, a fire hearth, tools, and evidence of plants used for basketry, floor mats, roof coverings, and clothing. Radiocarbon dating tests of the oblong house, which was about 14 to 18 feet in diameter (four to five meters) indicate an age of 9,490 years.

.To put the discovery in perspective, the famous cliff-dwellings of the Four Corners region in the Southwest are less than 2,000 years old, as are the houses associated with the Mayan pyramids in Mexico. The oldest previously known structure in Oregon, a pit house near Madras, dates back about 6,000 years. But the Paulina Lake house sheltered its inhabitants 9,500 years ago–before the invention of writing, before the Roman Empire, before the pharaohs of Egypt, before Stonehenge.

."This find adds a great deal of detail to our understanding of how the first Americans lived their lives," says Thomas J. Connolly, archaeologist and research director for the UO Museum of Natural History, who headed the investigation. "Our ideas previously were based on small bits of information gathered here and there–a kind of conjectural view. Now we have lots of solid evidence that really paints a much more detailed picture."

Connolly and his associates conducted their fieldwork between 1990 and 1992.

"But before we made the discovery public we wanted to make sure we had what we thought we had–and that took a couple years of work," Connolly says.

From blood residue on tools, for example, it appears the dwellers hunted bison, rabbit, bear, sheep, and deer or elk. Based on remnants in their hearth, their diet included chokecherries, hazelnuts, blackberries, and other fruits and nuts. They also processed hardwood bark, bulrushes and other plants used to make baskets, clothing, and floor and roof coverings. They kept warm and cooked with fires from lodgepole pine, ponderosa pine, and sagebrush.

Details of the Paulina Lake find are presented in Connolly's book, *Newberry Crater: A Ten-Thousand-Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderland* to be published this summer by the University of Utah Press.

"We have good evidence for fairly continuous occupation of Newberry Crater between 10,000 and 7,500 years ago," Connolly says. "But from the time of the Mazama eruption [which formed Crater Lake], we don't have any evidence for people residing in the area until about 3,500 years ago. That is a gap in our knowledge of three-and-a-half millennia and an indicator of just how much more work remains to be done."

The Paulina Lake site is about 25 miles from another site of major archaeological importance, Fort Rock Cave. In 1938, the late UO anthropologist Luther Cressman led an excavation of this site that uncovered about 90 sandals made of sagebrush bark and dating to the same period as the Paulina Lake site. That discovery altered theories anthropologists had held about ancient North Americans, doubling estimates of how long ago the first humans lived in the Northwest.

"The history of this area is no less interesting than the history of Mexico or Europe or the Middle East," says Tom Connolly. "But a lot of our history here in the Northwest has not been told."

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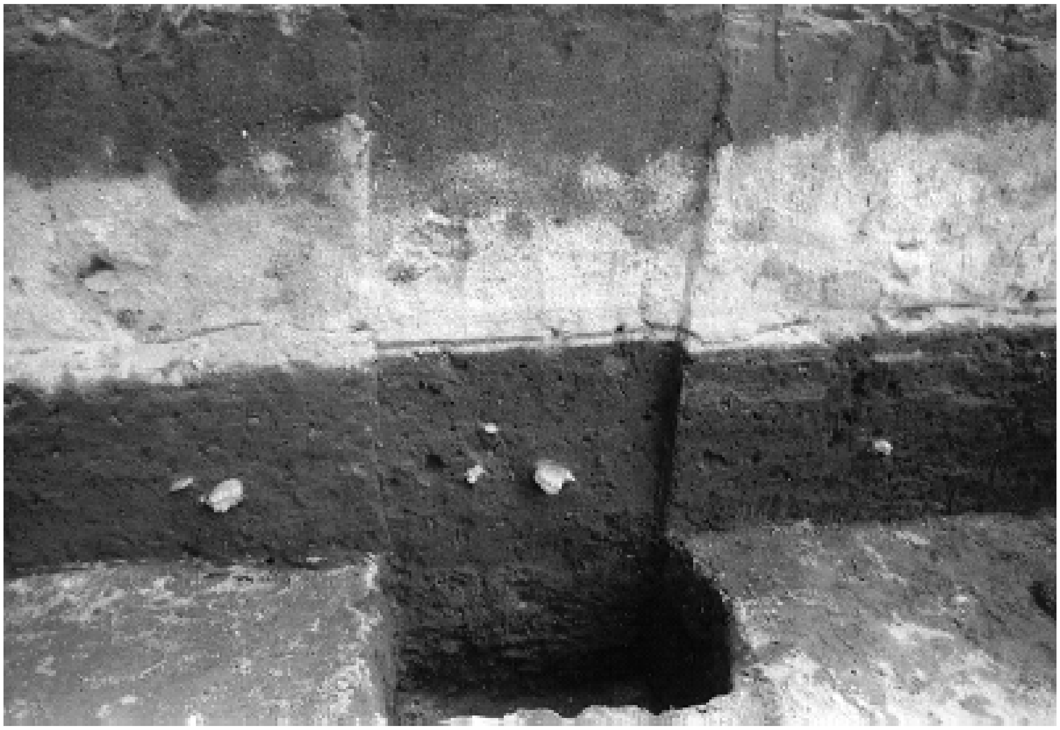
THE PAULINA LAKE SITE
An Early Holocene Occupation at Newberry Crater
Central Oregon

State Museum of Anthropology
Research Division
University of Oregon

Early Holocene living floor after completion of the 1992 State Museum of Anthropology excavations.

The Newberry Volcano caldera contains Paulina and East Lakes, and the products of eruptions subsequent to formation of the caldera including large obsidian flows. The Paulina Lake site is situated at the outlet of Paulina Lake, where Paulina Creek spills over the caldera rim and drains into the Deschutes River. Excavations at the site focused on cultural remains encased in sediments below a massive 7700-year-old airfall deposit of ash and pumice from nearby Mt. Mazama (present day Crater Lake).



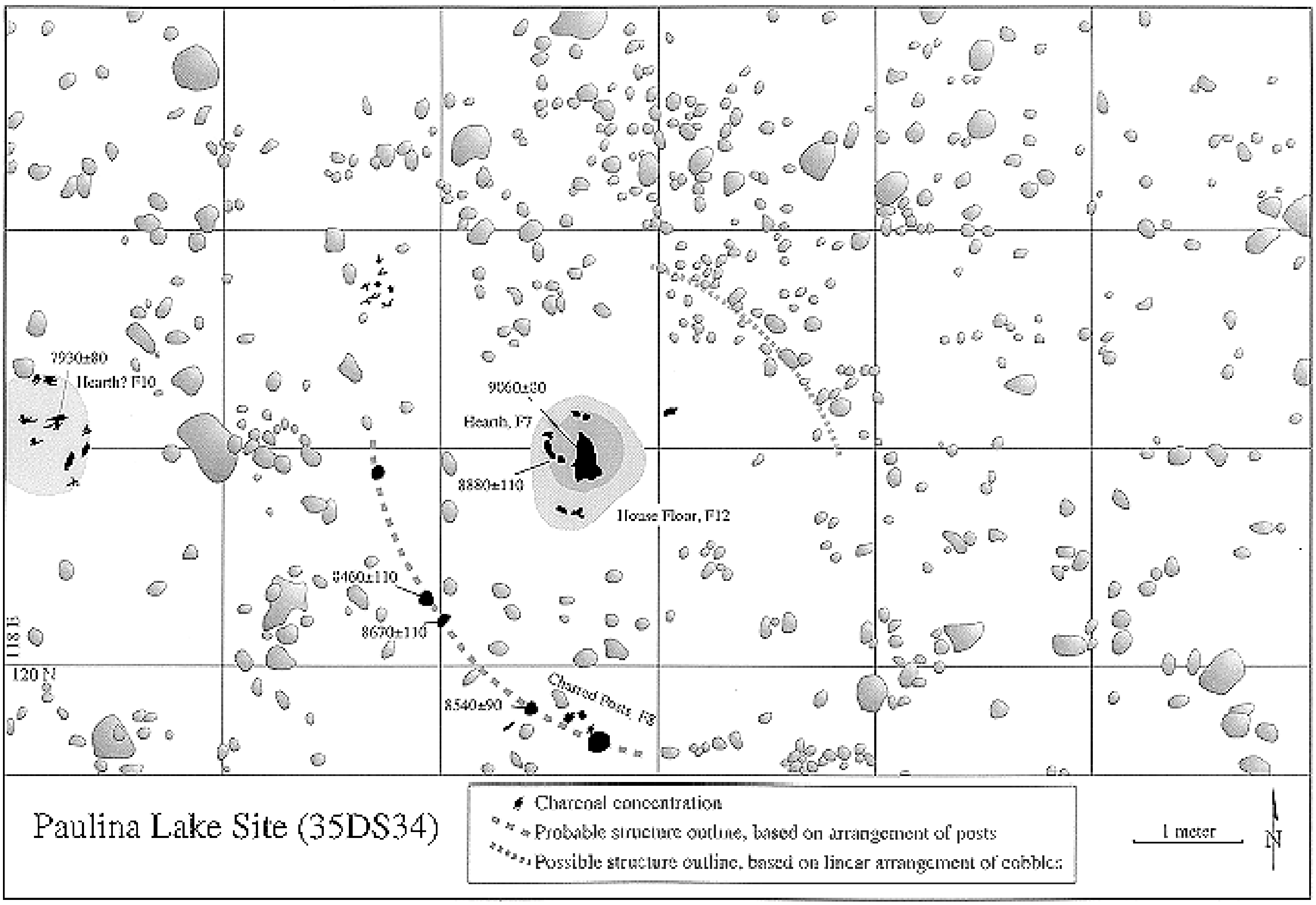
Soil profile from the Paulina Lake Site. The light layer is 7,700 year old Mazama tephra.

Cultural features associated with the pre-Mazama occupations suggest a residential camp where hunting and gathering pursuits were based. The perimeter of a domestic structure, containing a central fire hearth, was rimmed by the charred remains of five stout Lodgepole pine support posts. The area immediately around the hearth (i.e., the area within the structure) was relatively more rock-free than surrounding areas. Rock had been brought to the habitation area, possibly to help anchor the edges of habitation structures or for other purposes. The house floor did not appear to have been excavated below the contemporary ground surface. The interior space is estimated to have been about four meters from side to side, and up to five meters long.

Three of the support posts from the house perimeter were radiocarbon dated, producing a weighted mean radiocarbon date of 8555+/60 BP and a dendrocalibrated calendar age of 9490 years ago. Two dates from the hearth were older than the post dates by several hundred years (8880+/110 and 9060+/80), but the hearth contained relatively large chunks of charcoal, and this discrepancy is best explained by the use of older wood for hearth fuel than was used for the structural posts. The date derived from the posts is considered a better indicator of the time of occupation.

The central hearth had been excavated about 30 cm below the contemporary surface, and at its widest point measured nearly a meter in diameter. Macrobotanical and pollen analyses of soil samples from the hearth produced the greatest taxonomic diversity of any from the caldera, and indicated the presence of many plants of economic significance. Both lodgepole and ponderosa pine were used for fuel. Sagebrush wood was also identified; ethnographically the wood was used for fuel and the bark for rope, matting, and clothing. Pollen from bulrush and other sedges (used extensively in the area for matting and basketry) was recovered from the hearth, but from no other samples from the site. Evidence for economic plants included chokecherry pits, an unidentifiable nutlet fragment, and unidentifiable fruity tissues. Pollen analysis added evidence for Apiaceae (a family that includes many important root foods), Corylus (hazelnut), Rubus sp. (which includes salmonberries and blackberries), other grasses and herbs, and processed hardwood bark.

Finally, blood residue analysis has shown that small game (rabbits) may have been butcheredwithin the domestic structure near the hearth, while larger game (bear, deer or elk, and bison) was butchered outside the house.



Plan map of Early Holocene dwelling at the Paulina Lake Site.

State Museum of Anthropology, Research Division Home Page

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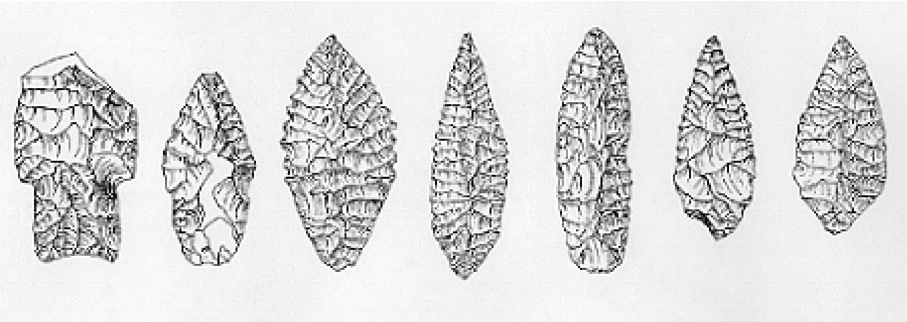
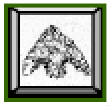
web page development: Mark Tveskov and Dr. Thomas Connolly
Last updated November 8, 1997

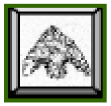
HUMAN AND ENVIRONMENTAL HOLOCENE CHRONOLOGY IN NEWBERRY NATIONAL VOLCANIC MONUMENT CENTRAL OREGON



Archaeological Investigations were conducted by The State Museum of Anthropology, University of Oregon, within the caldera of central Oregon's Newberry Volcano from 1990 to 1992. The work was jointly funded by the Federal Highway Administration and the Deschutes National Forest, in a contract administered through the Oregon Department of Transportation.

The caldera contains a number of flows of toolstone quality obsidian that was quarried throughout the Holocene. Excavations focused most intensively on Early Holocene occupations at the Paulina Lake site (35DS34), dating from 11,000 to 7700 (dendrocalibrated) years ago. Specialized studies included sourcing of obsidian toolstone recovered from archaeological contexts, and research on the distribution of products from the Newberry obsidian quarries outside the caldera. Paleobotanical studies provide a backdrop for reconstructing the nature and uses of the caldera through the Holocene.

 The Paulina Lake Site: An Early Holocene Occupation at Newberry Crater

 Obsidian Distributions from the Newberry Caldera Quarries

View of Newberry Volcano caldera from Paulina Peak on the south caldera wall; the northern rim of the caldera borders the north side of Paulina Lake. The Early Holocene-age Paulina Lake Site (35DS34) lies at the lake's western outlet.

The cultural paleosol at the Paulina Lake Site being exposed beneath the massive 7700 year-old Mazama tephra.

Dr. Dennis Jenkins exposing stone tools in the pre-Mazama sediments at the Paulina Lake Site.

ABSTRACT

Formal evaluation of 13 localities and data recovery at four archaeological sites was undertaken from 1990-92 in connection with proposed widening and realignment of the Paulina-East Lake Highway, located within the caldera of central Oregon's Newberry Volcano. These studies produced a wealth of information regarding human uses of the caldera and vicinity throughout the Holocene. Because the volcano has been active throughout the Holocene, and the caldera is well within the zone of airfall deposits from the eruption of nearby Mt. Mazama, the caldera provides a cultural record within a context of unambiguous and well-dated volcanic sediments. Botanical studies (macrobotanical and pollen analyses) provide information regarding the changing environmental context of human occupations in the caldera.

Early Holocene occupations documented at the Paulina Lake site (35DS34) were divided into three sequent cultural components, 11,500-10,500 (dendrocalibrated) years ago (Component 1), 10,500-8500 years ago (Component 2), and 8500 years ago to the time of the Mazama eruption, ca 7600 years ago. The most intensive Early Holocene occupations in the caldera are associated with Component 2, at which time at least one--and probably several--domestic structures were built. During this period the site served as a residential base, probably for a family or multi-family band, who established a summer home on the shore of Paulina Lake which served as a staging area for food gathering and hunting. Botanical studies show that the caldera environment was an open pine forest with a meadow and shrub-steppe understory.

Evidence from the caldera, and from archaeological and botanical studies elsewhere in central and south-central Oregon, indicate increasing desiccation of the environment in the millennium prior to the Mazama eruption. This period is represented by Component 3 in the present study. Increasing numbers of projectile points, decreasing numbers of cobble tools and abraders, and no evidence for domestic structures, all suggest that while the caldera was regularly used, occupations were less residential in nature in comparison those of Component 2.

The archaeological studies provide virtually no evidence for human presence in the caldera in the millennia following the Mazama eruption. While human settlement in central and southeast Oregon may have generally become less stable, due to broad scale climatic changes, it is likely that this change in caldera use at least partially reflects the biotic changes resulting from volcanic eruptions, which transformed the pre-Mazama pine woodland-meadow-steppe into a pumice desert.

Clear evidence for regular use of the caldera is seen after about 4000 years ago. All use of the caldera following the Mazama eruption, and following the emplacement of a series of obsidian flows containing very high quality glass, indicate that use was predominantly focused on quarrying and the production of mid-stage bifaces (apparently for transport out of the caldera) by small, specialized task groups. Those who mined the Newberry toolstone established small temporary camps, but not residential bases. These production-oriented camps and work stations produced enormous quantities of chipped stone waste, many large mid-stage bifaces and fragments, and only occasionally other tools or ephemeral hearth features. During this time Newberry Volcano obsidian occurs throughout the Deschutes River basin, northward along the spine of the Cascade Range, and into the Puget Sound/Gulf of Georgia area. The distant occurrences of Newberry obsidian, and its highly directional distribution to the north, suggest that the principal users of the Newberry caldera quarries resided in the upper Deschutes River basin, and where tied into exchange networks extending throughout the Columbia Plateau.

The intensity of quarrying activity in the caldera diminished during the last millennium following the eruption of the Big Obsidian flow. It is not clear whether this diminished use was in response to the eruption, which--like the earlier eruptive events--probably had a negative impact on the biotic productivity of the caldera and immediate environs. However, the regional archaeological record also indicates that significant changes occurred on a regional scale during this time. These changes include

the apparent concentration of a formerly dispersed population along the Columbia River and away from the upper drainages of its major tributaries, including the Deschutes River. Regular quarrying the Newberry obsidian flows continued, but possibly from much more distant village centers.

State Museum of Anthropology, Research Division Home Page

University of Oregon Home Page

web page development: Mark Tveskov and Dr. Thomas Connolly
Last updated November 7, 1997

A CATALOG OF PREHISTORIC BASKETRY AND OTHER PERISHABLE ARTIFACTS FROM EASTERN OREGON

STATE MUSEUM OF ANTHROPOLOGY
Museum of Natural History, University of Oregon

Prepared by:

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1986

Editing and Web publishing:

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1997

This catalog describes one of the most extensive collections of perishable artifacts in North America. Included in the collection are fine examples of basketry, matting, woven sandals and wood artifacts as well as artifacts fashioned from non-organic materials such as chipped-stone projectile points. What truly distinguishes this collection are the age and relatively good condition of the organic materials. The dry desert caves of the northern Great Basin preserved many of these perishable artifacts

for thousands of years. Luther S. Cressman, founder of the Department of Anthropology at the University of Oregon, assembled and documented most of the artifacts in this collection during the course of his six decades of field research.

Section I describes the history and significance of the collections, placing them in the context of North American basketry and perishable artifact research.

Section II provides background information on the evolution of basketry styles in Oregon.

Section III provides a historic chronicle of the field excursions or donations which have built the basketry collections, with site-by-site descriptions. Each OSMA collection is identified by an accession number. An artifact is associated with a particular accession by its catalog number.

An accession number was assigned to materials collected during a particular field trip, or donated by a particular individual. Because some sites were visited repeatedly, material from those sites have been assigned multiple accession numbers. Here you will also find links to site specific records which cover the various sites in greater detail.

Section I: History and Significance of the Collections	Section II: Oregon's Prehistoric Basketry
Section III: History of Basketry Related Research in the Northern Great Basin	Oregon State Museum of Anthropology Home Page

Last updated November 7, 1997

RESEARCH DIVISION

Current Research

Publications

Contact Information

Anthropology Links

The Research Division, a separate and self-supporting section of the University of Oregon Museum of Natural History, conducts archaeological research under contract with state agencies and a few large corporations, in compliance with federal and state cultural resource protection laws, as well as through grants and other awards. The museum presently handles work for Oregon Department of Transportation highway projects, and other large development projects.

The Research Division functions with five Ph.D. level administrators and regularly provides part-time employment for ten to twenty students. A huge amount of research on Oregon prehistory is represented by these endeavors. Scholarly reports on them are issued in the University of Oregon Anthropological Papers series, in partnership with the University of Oregon Department of Anthropology.

Excavations at the Limpy Creek Site (35JO39), Josephine County, Oregon, August, 1996.

Current Research | Publications | Contact Information | Links

University of Oregon Home Page

webmaster: Tom Connolly
Last updated April 18, 2000

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USGS/Cascades Volcano Observatory, Vancouver, Washington

Crater Lake, Oregon
Mount Mazama, Oregon

- **Current Activity**
    - *Link to:* Current Seismicity -- *Link courtesy University of Washington Pacific Northwest Seismic Network*
    - Cascade Range Current Activity Updates -- *includes Crater Lake*

- **Background and Information**
    - CASCADE RANGE SUMMARY: Crater Lake
    - DESCRIPTION: Mount Mazama Volcano and Crater Lake Caldera -- *Geographic Setting, Geologic and Eruptive Activity -- Crater Lake Caldera ... Crater Lake History ... Crater Lake Climactic Eruption ... Crater Lake National Park ... Caldera Formation ... Chaski Bay Landslide ... Crater Lake ... Discovery Point ... Geologic Setting ... Hillman Peak ... Hydrologic Monitoring ... Mazama Volcano ... Mazama Ash ... Merriam Cone ... Mount Scott ... Mount Mazama ... Palisade Point ... Phantom Ship ... Volcano Monitoring ... Wizard Island ...*
    - Mount Mazama and Crater Lake: Growth and Destruction of a Cascade Volcano -- *Klimasauskas, et.al., 2002, USGS Fact Sheet 092-02*

- **Current Hazards Report**
    - CURRENT 1997 HAZARDS REPORT: Volcano and Earthquake Hazards in the Crater Lake Region, Oregon -- 1997 Hazards Assessment Report

- **Special Items of Interest**
    - America's Volcanic Past - Crater Lake National Park -- *volcanic highlights and features*
    - America's Volcanic Past - Oregon -- *volcanic highlights and features*
    - Climb A Volcano - Crater Lake -- *"Family Fun - Picnic at the Top"*
    - Visit A Volcano - Crater Lake National Park -- *information, maps, driving information, tourism, links, etc.*

- **Maps, Graphics, and Images**
    - Maps and Graphics - Crater Lake

- CVO Photo Archives - Crater Lake
- "Pictogram" [168K,InlineGIF]: Crater Lake Caldera

- **Publications and Reports**
  - Publications and Reports - Crater Lake

- **Items of Interest**
  - Active and Potentially Active Volcanoes in Oregon -- *Excerpt from: Wright and Pierson, 1992, USGS Circular 1073*
  - America's Volcanic Past - Crater Lake National Park -- *volcanic highlights and features*
  - America's Volcanic Past - Oregon -- *volcanic highlights and features*
  - Caldera and Caldera Formation - Description -- *general information on calderas and caldera formation, including Mount Mazama and Crater Lake*
  - Caldera and Caldera Formation - Menu -- *general information on calderas and caldera formation, including Mount Mazama and Crater Lake*
  - Cascade Range Current Activity Updates -- *includes Crater Lake*
  - Cascade Range Summary - Crater Lake
  - Cascades Eruptions During the Past 4000 Years - Graphic -- *[Graphic,70K,InlineGIF] -- includes Crater Lake*
  - Cascade Range Volcanoes - Interactive Table -- *interactive table, includes brief volcano summary, links to current publications and research, includes Oregon Volcanoes*
  - Cascade Range Volcanoes and Volcanics - Menu -- *general information on Cascade Range Volcanoes and past Volcanic Activity, including Mount Mazama and Crater Lake*
  - Central Oregon High Cascades - Description
  - Central Oregon High Cascades - Menu -- *general information on Oregon Cascade Volcanoes*
  - Chaski Bay Landslide
  - Climb A Volcano - Crater Lake -- *"Family Fun - Picnic at the Top" -- includes Crater Lake Rim Drive, highpoint in park Mount Scott, down to the Lake at Cleetwood Cove, etc.*
  - Climb A Volcano in a Volcano - Wizard Island -- *"Family Fun - Picnic at the Top"*
  - Crater Lake - America's Volcanic Past
  - Crater Lake - Climb A Volcano
  - Crater Lake - Description -- *Geographic Setting, Geologic and Eruptive Activity*
  - Crater Lake - Geologic Setting -- *Excerpt from: Bacon, et.al., 1997*
  - Crater Lake - Historical Earthquakes -- *Excerpt from: Bacon, et.al., 1997*
  - Crater Lake - Lake Description
  - Crater Lake - Location Map -- *[Map,14K,InlineGIF] -- Modified from: National Park Service*
  - Crater Lake - Pictogram -- *"Pictogram" [168K,InlineGIF] -- "Annotated Photo Stories" -- learn about Crater Lake Caldera and Wizard Island in one picture*
  - Crater Lake - Visit A Volcano
  - Crater Lake National Park - America's Volcanic Past -- *volcanic highlights and features*
  - Crater Lake National Park - Climb A Volcano -- *"Family Fun - Picnic at the Top"*

- Crater Lake National Park - Location Map -- *[Map,14K,InlineGIF] -- Modified from: National Park Service*
- Crater Lake National Park - Visit A Volcano -- *information, maps, driving information, tourism, links, etc.*
- Current Seismicity - Link -- *Link courtesy University of Washington Pacific Northwest Seismic Network*
- Deformation Project - CVO Project Menu -- *general information on the Volcano Deformation Project, including the monitoring of Crater Lake Volcano*
- Discovery Point
- Earthquakes and Seismicity - Historical -- *Excerpt from: Bacon, et.al., 1997*
- Earthquakes and Seismicity - Menu -- *Crater Lake Earthquakes and Seismicity Menu*
- Eruptive History - Menu -- *Crater Lake Eruptive History Menu*
- Eruptive History of Mount Mazama and Crater Lake Caldera, Cascade Range, U.S.A. -- *Bacon, 1983, IN: JVGR v.18*
- Generalized Geologic Map of Mount Mazama and Vicinity - Map -- *[Map,38K,InlineGIF] -- Modified from: Bacon, et.al., 1997, USGS Open-File Report 97-487*
- Geographic Setting
- Geologic Map of Crater Lake Caldera Floor - Map -- *[Map,25K,InlineGIF] -- Modified from: Bacon, et.al., 1997, USGS Open-File Report 97-487*
- Geologic Setting -- *Excerpt from: Bacon, et.al., 1997*
- Hazards - Menu -- *Crater Lake Volcano and Hydrologic Hazards Menu*
- Hazards Report and Map -- *Current 1997*
- Hillman Peak -- *caldera highpoint*
- Historical Earthquakes -- *Excerpt from: Bacon, et.al., 1997*
- Hydrothermal Activity
- Location Map: Crater Lake National Park -- *[Map,14K,InlineGIF] -- Modified from: National Park Service*
- Maps and Graphics - Crater Lake
- Mazama Ash - Description
- Mazama Ash - Menu
- Merriam Cone
- Monitoring - Crater Lake Menu -- *Crater Lake Volcano Monitoring Menu*
- Mount Mazama - Description -- *Geographic Setting, Geologic and Eruptive History*
- Mount Mazama - Eruptive History - Menu
- Mount Mazama and Crater Lake: Growth and Destruction of a Cascade Volcano -- *Klimasauskas, et.al., 2002, USGS Fact Sheet 092-02*
- Mount Scott -- *National Park highpoint*
- Oregon Volcanoes and Volcanics - Menu -- *general information on Oregon Volcanoes and Volcanic Activity, including Crater Lake*
- Palisades Point
- Phantom Ship

- CVO Photo Archives - Crater Lake
- "Pictogram" [168K,InlineGIF]: Crater Lake Caldera -- *"Annotated Photo Stories" -- learn about Crater Lake Caldera and Wizard Island in one picture*
- Publications and Reports - Crater Lake
- Seismicity - Menu -- *Crater Lake Earthquakes and Seismicity Menu*
- Summary of the eruptive history of Mount Mazama -- *Excerpt from: Bacon, 1983, IN: JVGR v.18*
- Visit A Volcano - Crater Lake -- *includes information, maps, driving information, links, etc.*
- Volcanic Eruptions - Menu -- *a menu of famous volcanic eruptions, including Mount Mazama and the formation of Crater Lake*
- Volcanic Heights in the Western United States -- *includes Crater Lake*
- Volcanic Highlights and Features - Crater Lake National Park -- *"America's Volcanic Past"*
- Volcano and Earthquake Hazards in the Crater Lake Region, Oregon -- *Bacon, et.al., 1997*
- Volcano Deformation Project - CVO Project Menu -- *general information on the Volcano Deformation Project, including the monitoring of Crater Lake*
- Volcano Names -- *includes Crater Lake and Mount Mazama*
- Wizard Island Cinder Cone

- **Useful Links**
  - Useful Links - Oregon -- *includes Crater Lake*

CVO Educational Outreach

- CVO Educational Outreach Menu
  -- CVO Menu -- Educational Ideas, Information, Teacher's Aids, "Fun Stuff", Videos and Posters, USGS Educational Links, etc.

- Living With Volcanoes
  -- Facts and Information; Questions and Answers; Historical, Cultural, and the Economic Sides of Volcanoes; Tourism and Recreation Information, "Real-Time" World-Wide Volcano-Cams; and Information About "Dantes Peak"

Other Menus of Interest

- Cascade Range Volcanoes and Volcanics Menu -- *CVO Menu*

- Oregon Volcanoes and Volcanics Menu -- *CVO Menu*

HOME	Volcanoes	Publications	Hazards	Volcanic Glossary	Metric Conversion Formulas	Search Our Site
	Mount St. Helens	Monitoring	Research	Maps and Graphics		
	Living With Volcanoes	Useful Sites	Outreach	Photo Archives		

URL for CVO HomePage is: <http://vulcan.wr.usgs.gov/home.html>
URL for this page is: <http://vulcan.wr.usgs.gov/Volcanoes/CraterLake/framework.html>
If you have questions or comments please contact: <GS-CVO-WEB@usgs.gov>
01/06/03, Lyn Topinka

2005 Summer Session
Northern Great Basin Prehistory Project
Archaeology Field School

Dr. C Melvin Aikens and Kaylon McAlister document a rock shelter in the Craters of the Moon National Monument and Preserve.

In 2005, the University of Oregon Archaeological Field School will return to the Craters of the Moon National Monument and Preserve. The Preserve, situated in a remote part of southern Idaho's Snake River Plain, contains a wealth of archaeological resources that have only begun to be explored. Last year preliminary surveys were conducted and a number of new and exciting sites were discovered. This year we will continue the discovery process, surveying in previously unexplored parts of the Preserve, and excavating a variety of open air sites and lava tube caves.

Dr. L. Suzann Henrikson, who has conducted archaeological research in southern Idaho for the past 15 years, will supervise the 2005 survey and excavations.

Ashley Burnette excavates a unit outside of Kelvin's Cave.

For the past five years, the field school has been conducting research at **Kelvin's Cave**, in southern Idaho, and the **Connley** and **Paisley Caves** in central Oregon under the direction of Dr. Dennis L. Jenkins.

Application Form and Field School Qualifications

NEWS FLASH!!! The field school is now accepting on-line enrollment

applications for the Summer 2005 field session. Field school runs from June 20-July 29, 2005.

On-going Research Projects

- Kelvin's Cave, Idaho
- Paisley Caves, Oregon
- Connley Caves, Oregon

Links to Other Sites

- UofO State Museum of Anthropology
- Museum of Natural History, University of Oregon
- University of Oregon Home Page
- University of Oregon Anthropology Department
- Patricia McDowell - Geography
- Geography Department Home Page

Field School Information

- History of the Field School
- Course Description
- Enrollment,Course Fee, and Insurance
- The Setting and Living Arrangements
- Field School Required Tool Kit
- Personal Equipment List
- Teaching Faculty and Staff

Photo Galleries and Scrap Books

- 2003 Field School Scrap Book
- 2002 Field School Scrap Book
- 2001 Field School Scrap Book
- Artifact Gallery
- Scenic Photo Gallery

For additional information on the field school: L. Suzann Henrikson

Webmaster: Jason Carpenter
Site designed by: Leah Largaespada
Last Updated on 11/12/04 by: Montana M. Long

INQUIRY

Summer 1999

Psychologist Explores Intriguing World of "Pretend Friends"

Vivid Imaginings Play a Role in Early Development

Marjorie Taylor

.How would you feel if your child started talking to somebody who doesn't physically exist?

.Some parents delight in their child's imaginary companion as evidence of a lively imagination and creative mind. Others worry that the imaginary companion might be a sign that their child is in emotional distress or having difficulty communicating with other children.

."In the past a child with an imaginary companion might have been considered peculiar, shy, or even troubled," says Marjorie Taylor, a professor of psychology at the University of Oregon who has studied children and their pretend friends for ten years. "The reality is much more positive–and interesting."

.She notes that imaginary companions are surprisingly common; more than half of all children have them. The youngsters who create pretend friends tend to be less shy than their peers. They are also better able to focus their attention and to see things from another person's perspective.

."The research on imaginary companions suggests that pretend friends may be created to serve a variety of emotional needs, including a desire for companionship, a way to work through fears, or a method of dealing with actual or perceived restrictions," she says.

.Taylor's research in this area began by contacting 152 randomly selected families with children in the three- to four-year-old age group–a common age for children to have pretend friends. She interviewed both children and parents, asking questions such as whether the child had an imaginary companion, and if so, what it was like. She conducted follow-up interviews, again with both parents and children, three years later.

.This research provides the framework for her new book on the subject, *Imaginary Companions* *and the Children Who Create Them* (Oxford University Press, 1999).

."An active imagination is an important resource for children. An imaginary companion is evidence of its development–and as such is a positive indicator of psychological growth. In addition, a pretend friend can be an especially useful window through which parents can gain new insights about their children's thoughts and feelings."

.She explains that while children sometimes have difficulty assessing the reality of Santa Claus, the Tooth Fairy, or characters on television, they generally have a very good grasp of the make-believe nature of their imagined friends.

.Taylor is currently extending her research into other areas. One project is a cross-cultural study of parents' attitudes toward children's fantasy behaviors, including activities involving imaginary companions. The study will focus on parents in Oregon, Mexico City, and San Francisco's Chinese-American community.

. In another study, Taylor is working with adults to better understand the long-term effects of having an imaginary companion as a child. To explore this question, Taylor and her colleagues have interviewed and psychologically tested adults, some of whom had pretend friends, some of whom did not.

."Our preliminary results seem to indicate that those adults who had imaginary companions as children tend to be more open to new experience."

.Taylor reflects that while much of her work is with children, imagination plays an important role throughout life. By learning about children, we are learning about adults as well, she says.

."I am interested in the nature of the human mind," Taylor states. "Our imagination distinguishes us from other species. We use it to plan, to remember, to entertain, to get us through tough times. Research investigating the emergence of imagination in childhood, as well as investigating activities in later life, will help us more fully understand the human experience."

Back to INQUIRY home page