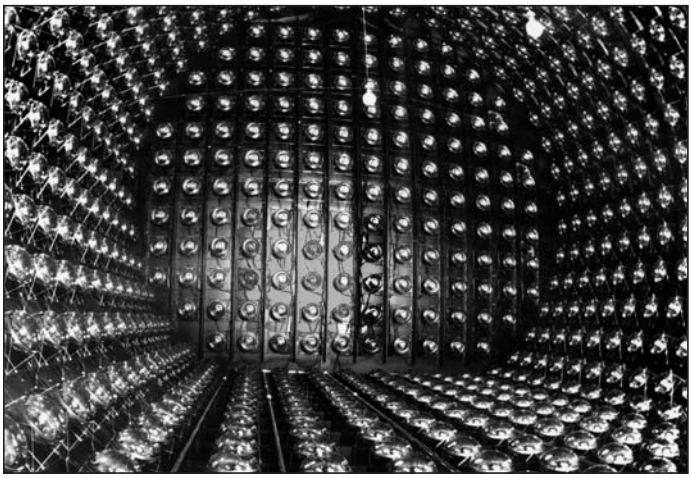
LANL
LOS ALAMOS NEWS LETTER
A publication of Los Alamos National Laboratory
Vol. 2, No. 16 • Aug. 9, 2001

Solved: The case of the missing neutrinos



A detector tank, which has 1,220 photo tubes that cover a quarter of the tank's inner surface, is designed to search for the neutrino with great sensitivity. *File photo*

by Todd Hanson

For 30 years, particle physicists have struggled with the mystery — where do all the solar neutrinos go? Now Los Alamos scientists, working as part of the Sudbury Neutrino Observatory collaboration, seem to have solved the puzzle. As it turns out, the neutrinos were not actually missing after all, but had been transformed to a different form in the course of their journey from the sun to Earth.

Since the early 1970s, numerous experiments have substantiated the theory that a shower of solar neutrinos was constantly streaming from the sun toward Earth. The problem was, however, that the amount of neutrinos detected by terrestrial neutrino detectors was only a fraction of the number predicted by detailed theories of solar energy production. There seemed to be something wrong

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Lab builds world's first neptunium sphere

by Kevin Roark

For the first time ever, a cross-section of nuclear materials scientists and technicians at the Chemistry and Metallurgy Research (CMR) facility have fashioned an eight-kilogram tungsten- and nickel-clad sphere of neptunium. The actinide metal sphere will be used in criticality safety and nuclear nonproliferation experiments at Technical Area 18, the critical experiments facility.

Not much is known about the properties of neptunium, a highly radioactive man-made material that is a by-product of nuclear reactors, except that it emits alpha, beta and gamma radioactivity. The critical mass is not well known, with documented values covering a very wide range of masses.

"We were starting from scratch when this project began back in 1997," said Stanley Bodenstein, who led the project in its early stages. "Nothing like this had been done before with neptunium. We were going to cast, machine and clad a sphere of material that is pyrophoric, meaning it can catch fire if exposed

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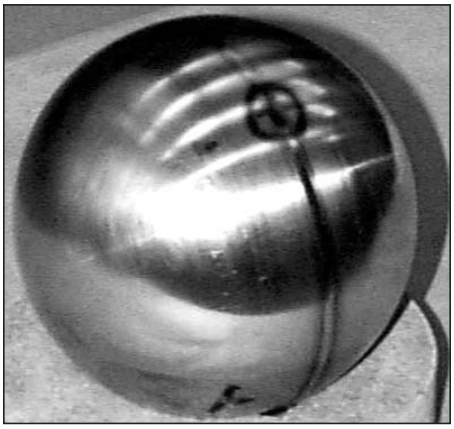

Starting from scratch, a team of Laboratory scientists and technicians have fashioned an eight-kilogram tungsten- and nickel-clad sphere of neptunium. The sphere, about the size of a baseball, will be used in criticality safety and nuclear nonproliferation experiments at Technical Area 18. *Photos courtesy of Actinide Chemistry Research and Development NMT-11*

INSIDE

LANSCE providing beam to users

by Dave Lyons

The Los Alamos Neutron Science Center is now up and running. LANSCE has begun beam delivery at both the Weapons Neutron Research Facility and the Manuel Lujan Jr. Neutron Scattering Center.

LANSCE comprises a high-power 800-million-electron-volt proton linear accelerator, a proton storage ring, production targets at the Lujan Center (LANSCE-12) and the Weapons Neutron Research Facility, and a variety of associated experimental areas and spectrometers. LANSCE provides proton beams for dynamic experiments that support defense science research at the Weapons Neutron Research and the Proton Radiography facilities, and for production of ultra-cold neutrons for basic science experiments at the WNR.

For its two national user programs, LANSCE produces intense beams of pulsed neutrons at both the Lujan Center and the Weapons Neutron Research Facility, which provide the Laboratory and U.S. scientific community with the capability to perform experiments that support both defense and civilian research.

This year's run cycle at the Lujan Center represents the first full cycle since 1997. Full run cycles, around six months in duration, have not been possible the last few years because facility upgrades and safety concerns that kept the facility in stand-down mode. An abbreviated run cycle was conducted last year for a limited number of users. Re-establishing the Lujan Center as a reliable provider of neutrons for research was one of the key directives that emerged from a February 2001 report on LANSCE's Lujan Center by the Department of Energy's Office of Basic Energy Sciences Advisory Committee, known as BESAC.

During the 2001 run cycle at the Lujan Center, over 100 experiments are scheduled to run on six user-program instruments. Experiments, which range from studies of new materials to biological protein studies, typically run from two to 10 days and often involve teams of researchers. In this year's cycle, 30 percent of Lujan Center users are from divisions across the Laboratory, and the remaining 70 percent are drawn from external experimental teams.

The external teams represent approximately 35 U.S. academic institutions, five national laboratories, seven foreign academic institutions, two members of industry and two U.S. government agencies. International users come from as far away as Germany, Slovenia and Japan. The Lujan Center expects to host approximately 150 unique users over the five-and-a-half-month run cycle that ends in mid-December.

Neutrinos …

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with either existing theories of the sun or our understanding of neutrinos.

Based on recently released research results, however, it is now apparent that this discrepancy is not caused by problems with any of the models of the sun, but rather by changes in the neutrinos themselves as they travel across space toward Earth from their birthplace in the core of the sun.

An international team of scientists have combined the first SNO results with measurements from the Super Kamiokande detector in Japan, another important Laboratory collaboration, to provide solid evidence that neutrinos oscillate. The evidence of solar neutrino transformation, along with the oscillation of neutrinos, is part of the mounting evidence indicating that these particles, which have been generally considered massless, indeed have mass, even if that mass is no more than the current estimate of one billionth that of a proton. Neutrino oscillations can only occur if neutrinos have mass.

Neutrinos — a Los Alamos strength

First theorized by Wolfgang Pauli 60 years ago, neutrinos are elementary particles of matter with no electric charge that exist in three known forms: the electron-neutrino, muon-neutrino and tau-neutrino. Their actual existence was not proven until 1955 when Los Alamos scientists Frederick Reines and Clyde Cowan Jr. used a detector called "Herr Auge" to gather the first tangible evidence of the existence of neutrinos. The discovery earned Reines the 1995 Nobel Prize

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LANL

LANL, the Laboratory bi-weekly publication for employees and retirees, is published by the Public Affairs Office in the Communications and External Relations (CER) Division. The staff is located at TA-3, Building 100, and can be reached by e-mail at *newsbulletin@lanl.gov,* by fax at 5-5552, by regular Lab mail at Mail Stop C177, or by calling the individual telephone numbers listed below.

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Neutrinos …

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and added to Los Alamos' reputation as a leader in neutrino science.

In 1996 a team of Los Alamos scientists used the Liquid Scintillator Neutrino Detector — a chamber filled with 60,000 gallons of pure mineral oil and 1,220 detectors — to demonstrate with neutrinos created by a linear accelerator that the tiny particles might indeed have mass. The nuclear reactions that fuel the sun emit vast numbers of electron-neutrinos, some of which change into muon- and tau-neutrinos, as indicated by the SNO experiment.

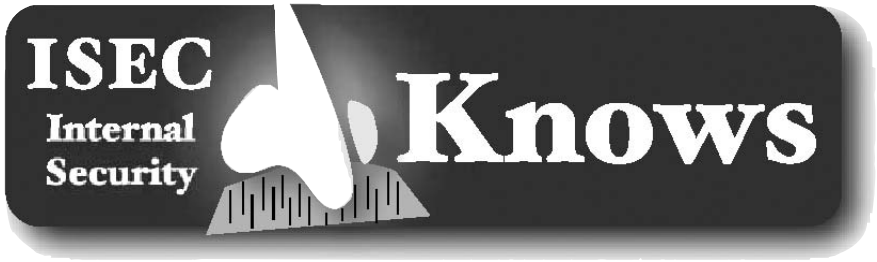
The solution to the missing neutrino mystery was made possible by the construction and operation of the SNO detector, a 12-meter-diameter, acrylic plastic, heavy-water-filled vessel located more than 6,800 feet below ground in a nickel mine near Sudbury, Ontario. The SNO detector uses an array of 9,456 photomultiplier tubes to capture the tiny flashes of Cherenkov light that are created when the roughly 10 solar neutrinos per day that are stopped or scattered in the 1,000 tons of heavy water contained in the SNO detector. The construction of the SNO began in 1990 and was completed in 1998. The SNO team began taking measurements in 1999.

For more than a decade, Los Alamos scientists have played a valuable role in construction, commissioning and detector calibration at SNO, as well as more recent work in data reduction and analysis. The group also has been instrumental in the design and construction of a neutral-current detector array that, when it is deployed about a year from now, will further increase the sensitivity of SNO. Los Alamos researchers currently involved in the SNO collaboration include Mel Anaya, Tom Bowles, Steve Brice, Andre Hamer, Andrew Hime, Klaus Kirch and Bill Teasdale and of Neutron Science and Technology (P-23); Mike Dragowsky, Malcolm Fowler, Geoff Miller and Jerry Wilhelmy of Isotope and Nuclear Chemistry (C-INC); and Jan Wouters of Advanced Information and Business Application Development (IM-8).

Next Step — examining the Standard Model

The discovery that electron neutrinos from the sun are somehow transformed into other neutrino types is important in understanding the Universe at its most microscopic level because the transformation of neutrino types has not been a part of the "Standard Model," the prevailing theory in particle physics.

There now seems little doubt that particle physics theoreticians now will have plenty of mysteries of their own to work on as they look for the best ways to incorporate this new information about neutrinos into existing or new comprehensive theories.



The 'Turkey Drop': It's not about Thanksgiving!

by Kevin Roark

You are a Los Alamos employee on foreign travel. While walking down the street, a stranger suddenly approaches you and asks if you have accidentally dropped the $1,000 he's holding. Knowing that you did not have that much money with you at the time, you now have two choices.

You can lie, take the money and run or tell the truth and quite possibly avoid a hornet's nest of bad fortune.

If you accept the money, there is a real possibility that it's a set-up. You may be approached later by yet another stranger who will confront you with accusations of robbery. Of course at this point the first stranger will be long gone. Chances are the money will be marked and you will find yourself in very hot water with either the foreign government or the individual, both with less than honest intentions, and you'll be a long way from home.

If you decline the money by explaining that it was not yours in the first place, all the trouble is avoided.

This tactic is called a "Turkey Drop." As an American citizen in a foreign country, you are easy to spot. Criminals use this operation to take money from you. It also can be used by a foreign intelligence service to blackmail you into cooperating.

Sometimes the scam starts when you apparently "find" some money just lying on the sidewalk. Again, you'll be confronted, and unless you immediately give up the cash, you're probably going to be in trouble.

The moral of the story. If the money's not yours, don't take it. This is true if you are on foreign travel or walking down the street in your hometown.

For more information about intelligence gathering techniques, contact ISEC at 5-6090.

Neptunium sphere …

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to oxygen, and so radioactive it must be handled remotely, completely hands-off."

The neptunium sphere team included Actinide Chemistry Research and Development (NMT-11), Materials Technology: Metallurgy (MST-6), CMR Facility Management (NMT-13), Experimental and Diagnostic Design (DX-5), Advanced Nuclear Technology (NIS-6), Security (S) Division, Environment Safety and Health (ESH) Division, and the Department of Energy's Los Alamos Area Office and Albuquerque Area Office.

Before the creation of the 3 1/4-inch-diameter sphere, about the size of a baseball, the Laboratory's criticality safety and nonproliferation work dealt with neptunium in a variety of other shapes. "No direct measurements for neptunium critical mass have been done," said Rene Sanchez of NIS-6. "The Lab possessed some quantities of neptunium, but not the right amounts or shapes. With this new sphere, we now have the capability to go beyond the current data, which are only estimates."

Creating the sphere from scratch is no exaggeration. "We had to ramp-up the entire process from basically nothing," said Bodenstein. "The whole thing had to be done in an 'alpha box' placed inside a 'hot cell.' Special tools had to be designed, built and tested by the technicians so they could be used with remote manipulators, one-of-a-kind melting and molding equipment had to be created and then all of it had to go through a DOE readiness assessment."

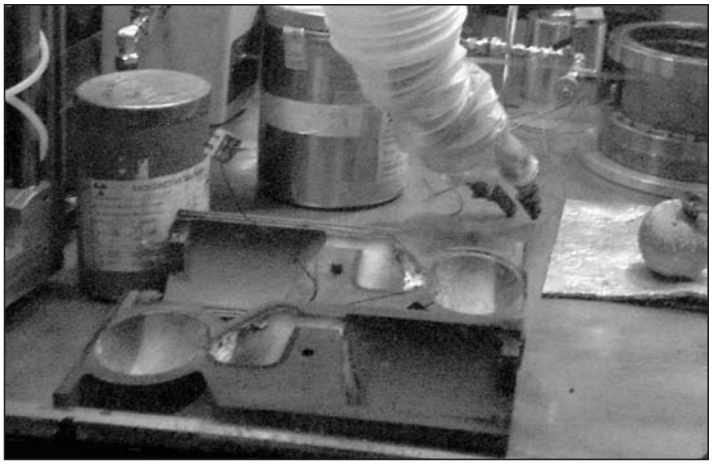
The alpha box and hot cell refer to equipment at CMR contained inside Wing 9 of the facility. An alpha box is a large highly specialized containment vessel built for a specific job and is intended to prevent the spread of radioactive particulate inside the hot cell. The work was accomplished inside one of CMR's 16 hot cells, small rooms that are heavily shielded with 3-foot-thick walls for radiation protection and outfitted with lead glass oil-filled windows and giant remote handling arms.

"There were many challenges along the way," said Bob Romero team leader at the hot-cell facility. "We were in the midst of removing a lot of materials at CMR, we were influenced by an upgrade schedule that called for technical improvements to the hot cells, and we were faced with changing security and safety requirements. We were interrupted several times because of funding, stand-downs, management changes, a division reorganization and of course, the Cerro Grande Fire."

And the team realistically had only one shot at getting it right. "All of the equipment, tooling, work instructions, hazard control plans, training, security plans, everything was prepared to give the team the highest reasonable probability to perform the task correctly and safely on the first attempt. Resource restrictions would have made a second attempt doubtful," said Bodenstein.

Getting everything in place for the DOE Readiness Assessment (RA) was a major success, according to team members, but the real accomplishment was how the assessment and final fabrication processes were completed.

"Often an RA and comment resolution process leading to the DOE approval of a project's 'readiness to proceed' takes about six months. Then the project itself typically takes many weeks to compete," said Bodenstein. "With close coordination between our team and the DOE RA team we were able to complete the RA in just nine days. Then with total involvement from the whole team we were able to deliver a finished product only four days later. Thirteen days, start to finish, this was unprecedented. Charles Grigsby, NMT-11 group leader, played a key role working with the Lab and DOE management to set the stage to conduct this project."



Work on the Neptunium sphere fabrication took place inside this hot cell at the Chemistry and Metallurgy Research facility. Technicians performed the "hands off" casting and machining of the sphere using manipulator arms and special handling tools behind special radiation shielding and oil-filled lead glass. *Photos courtesy of Actinide Chemistry Research and Development NMT-11*

As the team looks back on this major success, they agree that communication is what made this project work. "Security was a major driver, which required detailed planning and coordination," said Romero. "People worked weekends and evenings to prepare, sometimes into the wee hours of the night. It was a very intense effort. When problems occurred, we'd step back and evaluate what to do — we really used the five-step Integrated Safety Management process effectively to solve problems fast with worker safety at the forefront.

"There was total involvement across all organizations. Technicians were involved in development of the hazard-control plan and procedures. MST personnel developed and supervised the melting and casting of the materials and folks from DX-5 worked through the night machining the protective tungsten outer shell of the final casting," said Dave Yeamans, who led the project in its final stages. Sanchez added, "This was one of those projects that makes you very proud to be a Laboratory employee."

One technological advance was the fabrication of the one-of-a-kind yttrium-oxide coated graphite mold by Deniece Korzekwa and Phil Tubesing, both of MST-6. The specialized design integrated several thermocouples, a highly sensitive type of thermometer, to help control the cooling process of the molten neptunium. "From a metallurgist's point of view, a sphere is the hardest shape to cast," said Sanchez. "From a physicist's point of view, it's the best shape for experimentation.

"We've already learned many things from this project about how neptunium reacts to melting and cooling, how hard the finished product becomes — it turns out to be harder than steel, something we did not expect — and how difficult it is to machine," said Yeamans.

"There still is so much more to learn and there is a lot of interest in neptunium," said Romero. "An internal Los Alamos Neptunium Working Group sponsored by the Glenn T. Seaborg Institute for Transactinum Science already has begun to think about new studies with neptunium."

Public lecture series gives residents a chance to peer into ongoing Lab research

by Michael Carlson

Scientists and engineers will take on roles of educators through the Frontiers in Science Public Lecture Series that begins next month. The series is intended to inform the public about the diversity of research being conducted at the Laboratory.

Sponsored by the Laboratory Fellows, four free lectures a year are planned. Each lecture will be presented in Los Alamos, Santa Fe, Española and Taos to ensure that Northern New Mexico residents can attend. All lectures are scheduled for 7:30 p.m.

Charles Keller, of the Los Alamos branch of the University of California's Institute of Geophysics and Planetary Physics (IGPP), will talk about his global warming research Sept. 26 in the James A. Little Theater at the New Mexico School for the Deaf in Santa Fe. He will repeat that lecture Oct. 3 at Los Alamos High School, Oct. 4 at Northern New Mexico Community College in Española and Oct. 17 at the Taos Convention Center.

William Feldman, Space and Atmospheric Sciences (NIS-1), will discuss his work on the Lunar Prospector and Mars Odyssey mission Oct. 30 at Los Alamos High School. He will repeat his discussion Nov. 1 at Northern Community College in Española, Nov. 7 at the James A. Little Theater in Santa Fe and Nov. 8 in the Taos Convention Center.

Other lectures have not yet been scheduled.

Keller will speak in support of evidence for global warming by reviewing climate drivers for climate change and the effects of human activities on climate. The issue of global warming has been a contentious topic in recent years, with some scientists contending that the planet is warming because of chemicals added to the atmosphere by human activities and others arguing that evidence is doubtful.

Feldman will spend most of his lecture discussing the possibility of water on the moon. His scientific team at the Lab discovered evidence of lunar water three years ago. Also, one of Feldman's neutron spectrometers is headed to Mars where it will map that planet's water table. It is expected to be in Mars' orbit on Oct. 24; Feldman may discuss some initial findings of that mission as well.

For more information about the lecture series, contact Joe Ginocchio of Nuclear Physics (T-16) at 7-5630 or *gino@lanl.gov* by electronic mail. Also visit the public lecture series Web site at *http://stb.lanl.gov/fellows.html*.

Students explore cause and effect

A large group of students and teachers from schools throughout southwestern states came to the Laboratory to participate in some hands-on learning activities associated with rehabilitation of areas affected by forest fires. The students came to Los Alamos as part of a Summer Environmental Academy sponsored by WERC, a consortium for environmental education and technology development, based at New Mexico State University in Las Cruces, N.M. Numerous Laboratory and Department of Energy employees acted as mentors to the students during their one-week stay in Los Alamos. Teams of students went into burned areas on Laboratory property to assess damage caused by the Cerro Grande Fire, to perform remediation activities such as placing erosion-inhibiting devices in the areas and to learn how to sample soil, ash and runoff to determine whether they contain contaminants. After their field experience, and with the help of mentors and teachers from southwestern schools, students developed conclusions within their teams about how best to study, stop and interpret fire damage. After they reached their conclusions, the teams developed presentations about their findings. They shared their findings with mentors, teachers and Summer Environmental Academy sponsors during their final day at Los Alamos. WERC students from one group present their findings on sediment transfer. From left to right, students are Darren Wilson, Andrea Moore, Bryan Nelson, Benny Martinez, Tyson Shorty, Phillip Martinez and Dark Scott. Matt Johansen from DOE's Los Alamos Area Office acted as this team's mentor, along with Bryan Swain of WERC. *Photo by LeRoy N. Sanchez*

Volunteer opportunities

Available on the Community Relations Office (CRO) Web site

http://www.lanl.gov/orgs/cr/cr_volunteerop.html

Lloyd Young

Los Alamos researcher **Lloyd Young** has been awarded the 2001 Particle Accelerator Science and Technology Award. The award is given every two years to two individuals who have made outstanding contributions to the development of particle accelerator science and technology. Young received the award for "his invention, development and beam line operation of the resonantly-coupled radio-frequency quadrupole structure and the methods used to tune it and other RFQ structures." Young currently is doing research for the Spallation Neutron Source Project. He has been a Lab researcher since 1979.

John Carson

John Carson is the Laboratory's new manager of the Classified Information Systems Security Site. The new post for Carson, a 12-year employee of the Lab, is under the auspices of the Lab's Chief Information Officer Richard Kendall. In his new role, Carson will oversee cybersecurity issues at the Lab such as computer security plans and Laboratory compliance with Department of Energy cybersecurity orders and directives, he said. The position previously was in the Security (S) Division. Carson has 22 years of experience in computer security at the Laboratory and the former EG&G Inc. He has a bachelor's degree in electronics engineering technology from the DeVry Institute in Chicago.

Students venture into UC COSMOS

Four from state selected for summer enrichment program

Four New Mexico high school students will join students from throughout California this summer in an academic enrichment program called COSMOS, the California State Summer School for Mathematics and Science.

The University of California program, now in its second year, was offered to New Mexico students this year through the UC Northern New Mexico Office in connection with UC's management of the Los Alamos National Laboratory for the National Nuclear Security Administration.

Three UC campuses — Davis, Irvine and Santa Cruz — currently are hosts of COSMOS, a month-long residential program for qualified students who are completing grades eight through 12. Campuses select students for COSMOS based on test scores, grade-point average, achievement in science projects and competitions, teacher recommendations, motivation and community service.

COSMOS students live together in campus dormitories, participate in social and cultural events, and study topics not traditionally taught in high schools such as astronomy, computer science, wetlands ecology and ocean science, robotics, neuroscience and biochemistry, and volcanology. Special topics and lectures are provided by distinguished scientists and Nobel laureates.

Students interact with UC faculty, undergraduate and graduate students and have access to a wide variety of UC laboratories and other campus facilities. They take field trips to such places as the Jet Propulsion Laboratory in Pasadena, the Monterey Bay Aquarium, the Lick Observatory and the Human Genome Project at the UC-managed Lawrence Livermore National Laboratory.

The New Mexico COSMOS students are Lilly Allen, a sophomore at Capital High School in Santa Fe; Jordon Maril, a sophomore at Santa Fe High School; Adtihi Mehta, a senior at La Cueva High School in Albuquerque; and Erica Jane Knee, a Santa Fe High School senior.

COSMOS will be offered again to New Mexico students next spring for sessions in 2002. More information is available through the UC Northern New Mexico Office at (800) 985-7232 and online at *http://www.ucop.edu/cosmos*.

Lab to open its doors in September

The Laboratory has scheduled a "Family Day" on Saturday, Sept. 15, from 8 a.m. to 3 p.m. Access to secure areas for employees and their families is from 10 a.m. to 2 p.m. (pre-registration required by Aug. 15).

For more information and for secure-site registration, see the Family Day Web site at *http://int.lanl.gov/orgs/cr/familyday/*.

"Science at Home" is a publication developed by Science Education (STB-SE) to interest children, particularly those in grades four through eight, in science through hands-on activities. We are reprinting experiments from the book, along with other scientific activities, for employees to share with their families or just to enjoy themselves.

Come sail with me

Imagine being shipwrecked on a deserted island. Your only food is coconuts and your only companions are scorpions, spiders and snakes. In the far off distance you can just barely make out the mainland, but it's just too far to swim. You begin to build a raft by tying some logs together with vines, but suddenly a thought occurs: How will you propel it? You could paddle for a while, rest, then paddle some more, but that could take days, and if you should happen to get stuck in the wrong current, you could wind up even farther out to sea. You need a strong, swift, stable boat to brave the waves; something like a sailboat! Add a sail to your raft and you don't have to paddle all the time.

Ahoy, mates! If you want to be prepared for your next shipwreck, we have just the activity for you! You will begin by making a basic boat. Then by experimenting with the design of the sail and the position of the mast, you will discover how to get your boat to move the fastest.

The stuff you'll need

A styrofoam meat tray, egg carton, plate or any large piece of flat styrofoam; two plastic straws cut in half or two coffee stirrers; three toothpicks; scissors; a ruler; two sheets of construction paper; bathtub filled with 2 inches of water; timing device (stopwatch or clock with a second hand); pencil or pen; masking tape; a paper fan, a hand-held, battery-powered fan, a bicycle pump or fireplace bellows; and a data sheet.

Here's the plan

1. Cut a flat piece of styrofoam 2-inches (3.08 cm) wide and 5-inches (12.7 cm) long.

2. Place the ruler along the long side of the styrofoam. Make a mark 1 1/2 inches (3.81 cm) down from the top corner. This is point "Z." Repeat on the other long side (diagram 1).

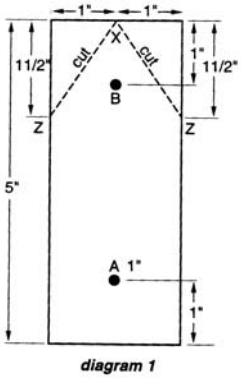


diagram 1

3. Place the ruler along the top edge of the styrofoam. Make a mark on the styrofoam at the 1 inch (2.54 cm) line, this is point "X" (diagram 1).

4. Draw a line from point "X" to point "Z" on both sides. Cut on the straight lines. This is the hull, or frame, of the boat.

5. Label mast positions A and B by measuring 1 inch (2.54 cm) in from the styrofoam ends (diagram 1).

6. Make two sails using construction paper. Choose from the patterns on diagram 2 or make your own. Cut out the sails. Cut two slits on each sail and weave half of a straw or a coffee stirrer through them (diagram 3).


diagram 2

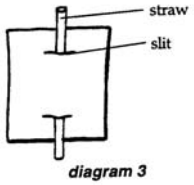


diagram 3

7. Place the toothpicks closely together at mast position A. Place a sail over them (diagram 4).

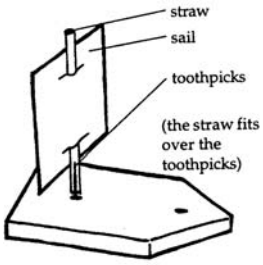


diagram 4

Record the shape of the sail on the data sheet.

8. Select someone to be the timer.

9. Place the first sailboat at the starting line at one end of the bathtub.

10. When the timer says "GO," wave the fan back and forth behind the sail, following behind the boat as it moves. What happens to the boat? How are you making it move?

11. Record the time it takes to get from start to finish (the other end of the tub) under trial 1 on the data sheet. Race this sailboat two more times and record these times under trial 2 and trial 3. Use the same method of wind power for every race.

Were the times the same for each trial? If not, why do you think they were different? What, if anything, was different in each trial?

12. Find the average time it took to sail across the tub and record it on the data sheet.

13. Conduct the same race using another sail. Find the average time it takes to get from start to finish. Compare the average of this sailboat to the average of the first one. How are they similar? How are they different?

14.To compare sails and sail positions, change the sail to mast position B and repeat steps 14 through 16.

15. Compare the trials. How were they the same? How were they different? Why was it important to keep the wind source as consistent or the same as possible during each trial? Why did you average the three trials for each sail and mast position? How did changing the mast position affect the time? What mast position and sail shape allowed the boat to move across the tub fastest?

Wrap-up

It is important that the only variables that change are the shape and placement of the sail. By keeping the wind source as consistent as possible, any change in results should be due to changes in the sail only. While the results will vary with regard to sail design, the trials where the mast was placed just behind the center of the boat (position A) should have given the best results.

What's going on here?

An effective sailboat must have minimal friction with the water, be well balanced and have a sail designed to efficiently transfer wind energy into forward motion. Sailboat shapes vary, but most have a tapered front edge to minimize "drag" or friction with the water. If the front end of a boat were square, water would pile up in front of the vessel, slowing it down. By putting a` point on the bow (front) of a boat, the water slips past the leading edge of the boat, moving off to the sides.

While the front of a sailboat minimizes resistance with the water, the sail maximizes resistance with the air. In theory, the more wind captured, the more energy transferred to the motion of the boat. In the early days of sailing, almost all vessels used square-rigged sails fastened to the mast directly across the ship. As the wind blows, it inflates the sail like a parachute. Because the sail is attached to the mast of the boat, the vessel moves forward with the wind.

While square-rigged sails offer the greatest amount of energy transfer when the wind is behind the boat, they are almost useless when the wind is either in front of or off to the sides of the vessel. To help combat this problem, a triangular sail called a lateen sail was developed. Instead of being rigged at right angles to the mast, lateen sails are hung on a boom that can set at virtually any angle to the mast. This way the sail can capture the wind from either side as well as the wind blowing from directly behind.

To capture even more wind, these sails are curved to provide more surface area. The more surface area, the more air the sail will "grab," and the faster the boat will go.

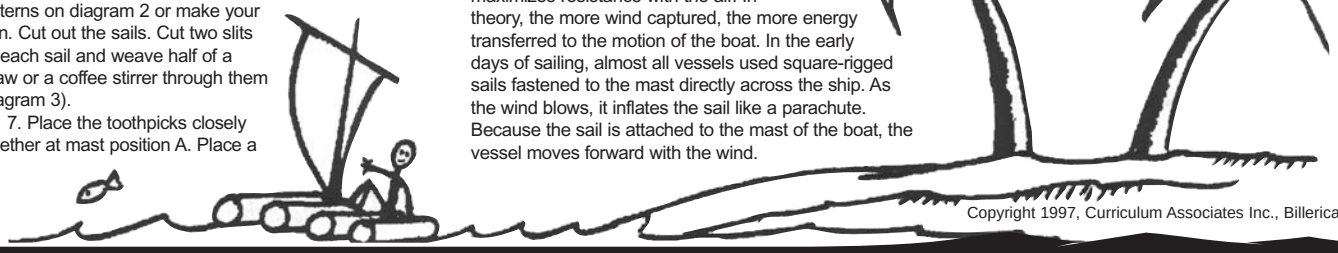
The most effective sail location is at the center of gravity of the vessel. The center of gravity is an imaginary point on an object where all the mass appears to be concentrated. If you were to suspend an object from its center of gravity, it would be perfectly balanced. On regularly shaped objects like a dinner plate or a ruler, the center of gravity is almost always in the middle. On a sailboat, however, the center of gravity is usually near the back, towards the center of the inside of the boat. To keep the boat from tipping from side to side, the mast is usually placed at the center of gravity.

Where does this happen in real life?

While many improvements have been made in the materials used in the construction of sailboats, most of the basic principles are as they were in ancient times.The design today that most closely resembles your bathtub boat is the sailboard used by windsurfers. Essentially a sailboard is a surfboard with a lateen sail. By gripping a curved bar to turn the sail, the surfer can quickly adjust for any wind angle, keeping the vessel on course. To help keep the boat stable, most sailboats and sailboards also have a keel, which is a board that extends down into the water. Keels serve two main functions. They lower the boat's center of gravity, giving it better balance in rough water, and they help to keep the boat on course and prevent it from tipping over.

Now try this

Experiment by using plastic or cloth sails and balsa wood, cardboard or plastic to make the hull. How do these materials affect the speed and stability of the boat? Try adding a keel to see how the speed and stability are affected. Change the shape of the hull to see if it makes any difference. Many racing yachts use a variety of sails for different wind conditions. Try combining different shapes of sails on one boat and experiment to see which combination is most effective.



Local flyers are well grounded

by Michael Carlson

Juan Baldonado chooses to fly with his feet on the ground and his eyes on the sky. A mechanical technician with Space and Atmospheric Science (NIS-1), he builds and flies model airplanes of different shapes and sizes.

He also is president of the Los Alamos Aeromodelers Club, which boasts 20 members and is sanctioned by the Academy of Model Aeronautics based in Muncie, Ind. Some of these enthusiasts can be found on weekends at a landing strip in Española or in other parts of Northern New Mexico.

Baldonado currently flies a T-38 in Thunderbird colors and a piper J3 Cub.

"I chose the Thunderbird scheme because it's attractive. And I've always been a big fan of the Air Force Thunderbirds," he said.

Juan Baldonado poses with his T-38 that is decorated in Thunderbird colors. As president of the Los Alamos Aeromodelers Club, he builds and flies model aircraft. Baldonado is employed with Space and Atmospheric Sciences (NIS-1) and is in the process of building a 29 percent scale Aeroworks Edge 540. *Photo by Michael Carlson*

He doesn't build his aircraft from scratch. Instead, he buys kits that contain the parts and blueprints. And he still has to do the gluing, sanding, painting and wiring. Occasionally, he'll make a few of his own modifications to an airplane.

"They're just sticks of wood in a box. The hobbyist must actually build the plane," he said. "But you can't modify the design too much because they'll crash."

The cost of a model airplane can range from a few hundred dollars to more than several thousand, so losing a plane can dent the pocketbook.

He has lost a few planes since he started this hobby 10 years ago. Once he took his eyes off a plane, which took three months to build, when his mother gave him a goodbye kiss, and he lost control of his aircraft.

"If you're willing to fly, you're willing to risk it," he said. "Use all of your technical skills to minimize the loss of your aircraft. You can't take your eyes off your plane when it's in the air. Otherwise, you'll lose it."

Currently, Baldonado is building a 29-percent-scale Aeroworks Edge 540. When finished, the airplane will have cost him about $3,000. That price includes a 4.8 horsepower twin-cylinder engine that he bought in an Albuquerque hobby store for $900.

Baldonado also is teaching others to fly model aircraft.

Ping Lee has been a member of LAAC for a couple of years but admits he's not very good at flying radio-controlled aircraft. But with Baldonado's instruction, Lee is finally mastering the art of flight from the ground.

Lee has a license to fly real aircraft but said it's harder to fly models.

Chief of staff for the associate Laboratory director for nuclear weapons (ALDNW), he's crashed or lost more than a dozen airplanes since he started this hobby 20 years ago; one that he has been involved in on and off.

Ping started his career at the Laboratory as a summer student in 1973. He's a graduate of the University of California, Berkeley, and the Massachusetts Institute of Technology.

LAAC works with Northern New Mexico communities to educate children and adults about aviation. The group is active within the Boy Scouts and Cub Scouts, assisting boys with their airplane-related projects.

LAAC meets in the "old firebarn" at 4017 Arkansas, in Los Alamos at 7 p.m. the second Wednesday of every month. For more information, contact Baldonado at 662-4794.

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LALP-01-4