

We proudly dedicate SURF 2005 to the Paul K. Richter and Evalyn E. Cook Richter Memorial Funds. The generous annual contributions from the Richter Memorial Funds fostered the development, growth, and maturing of the SURF program and created an important legacy at the Institute. Since 1982, 508 Richter Scholars have had the extraordinary opportunity to engage in research with mentors working at the frontiers of their fields. We acknowledge with deep gratitude the significant support from the Richter Memorial Funds.

SURF has been dedicated to the following people and organizations:

1985	Dr. Ernest Swift
1986	Dr. Lee A. DuBridge
1987	Dr. Robert P. Sharp
1988	Dr. Ray D. Owen
1989	Dr. Hans W. Liepmann
1990	Dr. Fredrick H. Shair
1991	Dr. Lew Allen Jr.
1992	Dr. John D. Roberts
1993	Dr. Robert E. Bacher
1994	Dr. Edward C. Posner
1995	Mr. Samuel P. Krown
1996	Dr. Edward B. Lewis
1997	Dr. Harold Brown
1998	Dr. Thomas E. Everhart
1999	Dr. Ward Whaling
2000	Dr. Terry Cole
2001	Dr. William Whitney
2002	Dr. Edward C. Stone
2003	Dr. Thomas A. Tombrello, Jr.
2004	Dr. Harry B. Gray
2005	Paul K. Richter and Evalyn E. Cook Richter Memorial Funds



David Baltimore

President's Message

Congratulations to SURF on another successful summer! I am particularly proud of the three SURF fellows—Lydia Ng, Kitty Cheung, and Erkam Gundogdu—who worked in my laboratory this summer. They are outstanding students, they worked hard, and they learned a lot. Each has a very promising future! It has been a pleasure to get to know them.

I am deeply grateful to the many donors who provide funds for SURF student stipends through their annual contributions or through endowments. Your investments in our students today will pay important dividends in their futures and, more broadly, in the future of the nation and the world, as they commence their careers and expand their influence in the organizations with which they associate.

The completion of the SURF endowment is a high priority in the Institute's capital campaign, **there's only one.caltech**. I am extremely pleased to announce a special offer to create a named SURF endowment using a \$50,000 matching gift contributed by an anonymous donor. Endowments may be named as the contributors designate, and each will support one SURF fellow annually. I hope that you will consider taking advantage of this remarkable opportunity to invest in our bright and talented students and ensure the future of the SURF program. Thank you to those who have generously donated to the SURF endowment!

Caltech is an extraordinary institution, a world leader in research and education, and SURF is one of the programs that keeps the Institute at the forefront. We will strive toward our goal of fully endowing the SURF program. SURF's future is bright with the creativity and synergy generated through collaboration of students and mentors.

Report of the SURF Board

The SURF Board is a voluntary support organization consisting of individuals who are dedicated to the educational values of undergraduate research at Caltech, and who, through their advice, encouragement, and financial support, contribute to the vitality, continuity, and effectiveness of the SURF program.



John Gee

As summer ends and we approach SURF Seminar Day on October 15, SURF 2005 will be complete. It was an outstanding year!

We dedicated SURF's 27th program to the Paul K. and Evalyn E. Cook Richter Memorial Funds at the annual Kickoff Dinner in April this year. This dedication recognizes and honors the long-term significant support from the Richter Memorial Funds.

The Richter Funds began to support student-faculty collaboration at Caltech in 1968—11 years before the founding of SURF—to promote individual achievement. After the founding of SURF, the Richter Funds were redirected to support the fledgling program, and from that modest beginning of \$12,000, the trust has now contributed well over a million dollars and has supported 508 individual students!

This year at Caltech and at JPL there were 297 Caltech students and 126 non-Caltech students for a total of 423 SURF students. With the additional 138 students from other programs coordinated by the Student-Faculty Programs Office, the total number of students benefiting from the undergraduate research experience was 561, an increase of 10% over 2004.

The Fund Raising Committee of the SURF Board under the leadership of Carl Larson has been busy this year—in close cooperation with the Caltech Development Office—to achieve the goal of raising \$10 million for the SURF endowment as part of the **there's only one.caltech** campaign. As of August 1, 2005, the contributions toward the goal were close to \$4.2 million or 42% of the goal. Our thanks go to Carl Larson, Jim Cutts, Kirk Dawson, John Glanville, and Carel Otte for their service on this very important committee.

We are delighted that an anonymous donor has contributed funds to match up to \$50,000 toward the creation of a SURF endowment! The full cost of an endowment is \$125,000. Four donors have used the match of funds to endow a SURF stipend.

We are pleased that Kirk Dawson, Bob Roney, and Sean Upchurch were re-elected for second three-year terms. Leslie Maxfield (SURF '92, '93, '94, BS '95) and Phoebe Dea (PhD '72) were elected to three-year terms. Kirk Dawson has accepted the role of Vice Chair to replace Carel Otte. John Gee agreed to serve another term as Board Chair.

Sean Upchurch, though a busy graduate student at the City of Hope, continues his committee work to recruit session chairs for SURF Seminar Day. In addition to recruiting the number of alumni necessary to chair each session, Sean and his committee have solicited additional people to serve as alternates to help in case of last minute cancellations. The special program for visiting students has helped to make the Admissions Office open house more successful.

We were saddened by the death of long-time SURF Board member Al Schaff this year. We extend our deepest sympathy to his family.

Carolyn Ash and her staff continue to be outstanding in the administration of the SURF program. We also thank the JPL Education Office staff for their strong support of SURF!

Thank you to members of the SURF Board and its committees. Our mission is to provide energetic and enthusiastic support for the SURF program and to strive to achieve the \$10 million fund raising goal.

I would like to express our deep appreciation to the donors who support SURF with their contributions and to the many others who support SURF in various ways to ensure its success.



The Campaign for SURF

THERE'S ONLY ONE.CALTECH! The theme of the Institute's capital campaign signals the unique programs and remarkable people that help set Caltech apart from other institutions. SURF is one of the priorities in the campaign with the significant goal of increasing the SURF endowment by \$10 million.

Many individuals and families have responded to the campaign through their generous gifts and pledges.

We are deeply grateful to Carl and Shirley Larson for the extraordinary gift of \$1 million to the SURF endowment! "We think SURF is a great Caltech program," say the Larsons. "It gives students the best possible opportunity to determine whether a career of basic science research is what they really want to pursue or whether they want to apply their Caltech training in other ways. Best of all, it helps them make such an important decision early in their lives. There is only one Caltech and SURF is one of the many reasons."

With great appreciation, we announce the creation of the following endowments this year!

Kirk and Marjory Dawson Family SURF Endowment [estate plan]

Frederick W. Drury, Jr., SURF Endowment

Fred and Jean Felberg SURF Endowment

Heather and Paul Haaga SURF Endowment

Robert T. Herzog SURF Endowment

Larson Scholars Program

Thomas Lauritsen SURF Endowment

Joanna Wall Muir SURF Endowment

Ernest R. Roberts SURF Endowment

Mary Vodopia SURF Endowment

Frank W. Wood SURF Endowment

The Frank W. Wood SURF Endowment

Caltech alumnus Dick Cox (BS '42) created the Frank W. Wood SURF Endowment to honor and memorialize his classmate and long-time friend. Frank Wood is described as an engineer, archeologist, story teller, and perpetual student. After spending a long and rich career with Mobil Oil, he began taking courses in archeology at UCLA, specializing in Mayan studies, almost earning a Ph.D. Dick says that Frank was innovative and curious, and since SURF fosters those characteristics in Caltech students, the Frank W. Wood Endowment is a fitting memorial.

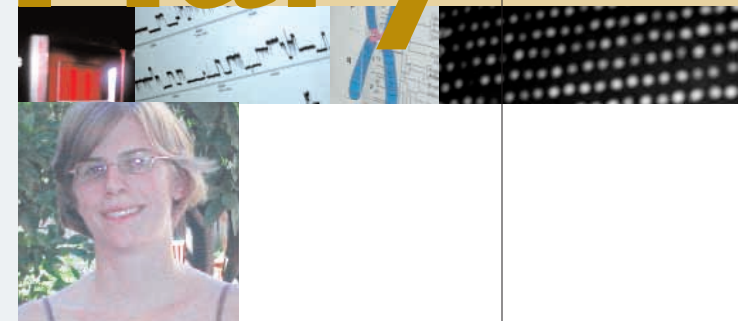
Mary Ollenburger, the first Frank W. Wood SURF Fellow, is a senior majoring in mechanical engineering. She is working this summer with Dr. Ken Pickar, Visiting Professor of Mechanical Engineering, on a project entitled *Product Design for Developing Communities: Teaching Engineering for Two-Thirds of the World*. The project entails developing a curriculum for an innovative engineering course, including lectures, readings, and group projects to design a marketable product for the developing world. This project has potential global importance since two-thirds of the world now lives on less than two dollars a day, and engineers are not trained to design products accessible for people living at subsistence levels.

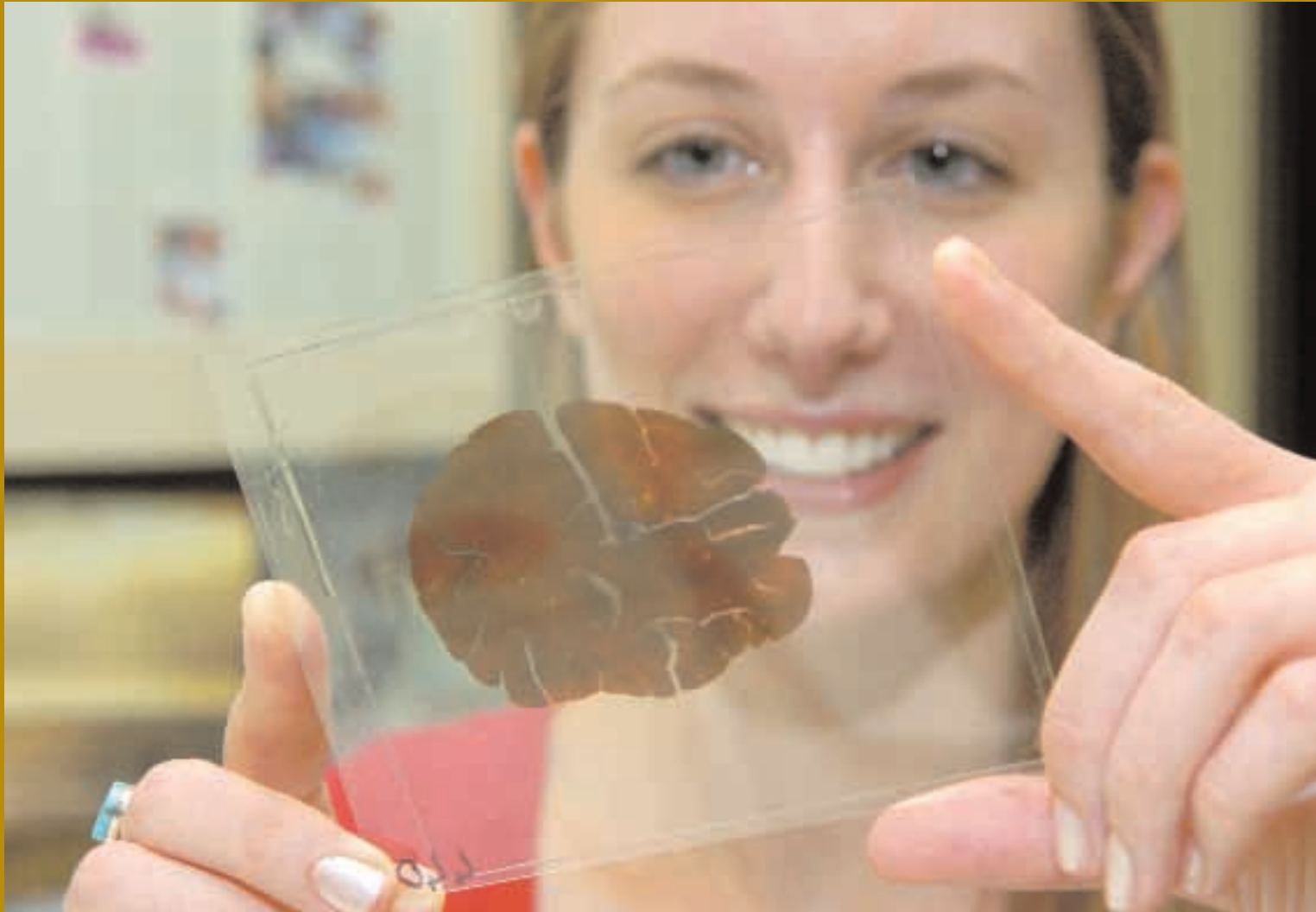
Mary's wide-ranging interests and experiences have prepared her for this project. She spent time in Argentina learning about and working with Argentine Unemployed Workers' Movements and worker-controlled occupied factories. She volunteered with Centro de Servicios Crisianos (Cedescri) in Guatemala, an organization that develops and distributes efficient woodburning stoves, composting dry latrines, and rope wells to communities in the Guatemalan Highlands area affected by the civil war. They also teach efficient organic farming techniques and care and use of medicinal plants. The people she met in Guatemala helped identify problems that need solutions. One of these projects is to develop a stove design that either uses less firewood or uses an alternative fuel—because in many places, the use of wood fuel is causing deforestation and respiratory diseases from indoor air pollution.

Mary participates in Engineers for a Sustainable World at Caltech, and in her spare time, she enjoys hiking, backpacking, and cycling.

“I’VE BEEN WORKING WITH PROFESSOR PICKAR TO FIND READINGS AND REFERENCE MATERIAL FOR THE CLASS AND TO DEVELOP THE SYLLABUS SO THAT WE CAN FIT EVERYTHING INTO 10 WEEKS. I NEVER REALIZED JUST HOW HARD IT IS TO PREPARE TO TEACH A CLASS!”

Mary





Corinna Zygourakis, Heather and Paul Haaga SURF Fellow, SURFed with John Allman, Frank P. Hixon Professor of Biology, this summer on *The Role of the Frontoinsular Cortex in Social Cognition*. “I am thankful to the SURF program for giving me a taste of what real research is like. As I delve deeper into my project, the challenging, yet exciting aspects of research become more apparent: the second you have a problem figured out, another one—more interesting than the first—always pops up.”

Ernest R. Roberts SURF Endowment

Karen Roberts (BS '74) and James Sagawa (BS '63) created the Ernest R. Roberts SURF Endowment in memory of Karen's father. Karen writes, "My father received his Ph.D. in thermodynamics from the Swiss Federal Institute of Technology. He valued education and encouraged us to get the best education possible. After he died, we knew he wouldn't have wanted people buying flowers in his memory, and we were trying to think of a worthy cause to suggest instead. My mother mentioned that they had contributed to SURF for many years, so we let friends and relatives know that donations to SURF would be appreciated in lieu of flowers. At the time, Mark Reinecke, Senior Development Officer, mentioned that we could set up a SURF endowment. We thought about it, but we could not commit to \$125,000, so we regretfully declined. Recently we learned of the incredible special matching offer to fund SURF endowments. We felt this was an opportunity we couldn't pass up! The donor's generosity has made it possible for us to establish the Ernest R. Roberts SURF endowment, and I can't think of a better memorial for my father."

Emily Russell is the first Roberts SURFer. A junior majoring in physics, she is working with Professor of Physics Emlyn Hughes on *The Large Hadron Collider: Testing of Detector Components and Study of the Higgs Decay Modes*.

Emily had the splendid opportunity to carry out her research at CERN, the European Organization for Nuclear Research in Geneva, Switzerland. This facility, currently under

construction, will become the frontier of high-energy particle physics when it begins operations in 2007. Professor Hughes says that the international collaboration is interesting, challenging, and complicated, and the students fit in very well, "but the gloves were off, and the students saw both the good and the bad of these large projects." He added, "Emily did hard theoretical calculations as well as helping the CERN group with testing of various electronics relevant to a large construction project."

Emily says, "I intend to pursue a Ph.D. in physics after graduating from Caltech, and to continue doing physics research. It is also an amazing opportunity to encounter the international community in physics, rather than being exposed only to the small (though rich) community at Caltech. More specifically, I have a particular interest in high-energy and particle physics; my proposal to work at the Large Hadron Collider (LHC) allows me to be involved in building what may very well be a ground-breaking high-energy laboratory, fueling research in my preferred specialty for the next several years, if not several decades. This will also teach me a great deal about some of the particle physics that will be studied at the LHC."

In her spare time, Emily composes and arranges music for a capella and sings with two a capella groups, Fluid Dynamics and Out of Context.

"IT WAS A GREAT EXPERIENCE TO WORK AT AN INTERNATIONAL LABORATORY LIKE CERN, AND I WAS THRILLED TO HAVE THE CHANCE TO TRAVEL AROUND EUROPE ON THE WEEKENDS!"





Priya Kollipara, Joanna Wall Muir SURF Fellow, is a senior majoring in astrophysics. She worked with Anthony Readhead, Barbara and Stanley R. Rawn, Jr., Professor of Astronomy, on *Analysis and Imaging of Polarized Microwave Foreground Sources With the Cosmic Background Imager*. “I’ve enjoyed the experience I’ve gained working with my SURF research groups. I’m deeply grateful to them for what they’ve taught me, and I hope I’ve provided some worthwhile contributions to their work.”

Mary Vodopia SURF Endowment

Sam Vodopia (BS '54) and Carol Hasson recently established the Mary Vodopia SURF Endowment in memory of Sam's mother. The endowment will support a woman SURF fellow in either the Division of Humanities and Social Sciences or Geological and Planetary Sciences.

Sam says of his mother, "She passed away just shy of her 100th birthday. As a young girl growing up in a village on an island in the Adriatic Sea, she did not have the opportunity to go to school because the couple that were the entire faculty of the village school left and were not replaced. As I remember, she said the husband taught the boys and his wife taught the girls. My mother's older sister, who had gone to school, taught Mother to read by writing the letters of the alphabet with a twig using the dirt on the blades of their hoes as a slate—that is, when the hoes were not being used in growing vegetables. In spite of her lack of opportunity to go to school, or perhaps because of it, my mother valued education very highly.

"When I left for Caltech in 1950 she gave me all the money she had in savings, all of \$600, not a small sum in those days, because it represented one whole year's tuition at Caltech. This is just one of the reasons I want to have a SURF fellowship named in her honor. She was a fierce advocate for women's rights, thus the preference for a woman student, and in the social sciences because of her interest in politics. She practically memorized all of the U.S. Constitution for her citizenship exam."

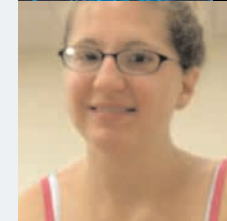
The first Mary Vodopia SURF Fellow is Lisa Lyons, a sophomore majoring in computer science. She worked this summer with Ralph Adolphs, Professor of Psychology and Neuroscience, on a project entitled *Using Computer Vision for Face Detection: An Application in Social Neuroscience*.

In her research project, Lisa evaluated the effectiveness of two programs for face detection. She says that new eye tracking technology allows, for the first time, the quantitative measurement of facial gaze during naturalistic social interactions. "We hope that the new technology will eventually lead to better understanding of social disorders like autism," she says.

In high school, Lisa served as president of the Literature Club, and reading is one of her greatest interests. She says, "The club discussed books from a wide variety of genres to expose members to new topics and ideas. This was definitely one of the most enlightening activities I ever participated in!" For her senior project, she built an autonomous robot, her first experience in programming hardware. She was involved in Future Business Leaders of America and National Honor Society, and she participated in community service for various organizations including Rotary Club.

"MARY VODOPIA WAS A VERY STRONG AND GENEROUS WOMAN. I AM PROUD TO HAVE BEEN CHOSEN FOR A FELLOWSHIP IN HER NAME!"

Lisa





Michael Turk, Tab and Keri Stephens SURF Fellow, is a senior majoring in physics. He worked this summer with professor of physics Nai-Chang Yeh. "When I applied for my first SURF, I did so in the hopes that I could find what truly interests me, and the research experiences through this program have definitely helped me."

Robert T. Herzog SURF Endowment

We heartily thank Caltech alumnus Bob Herzog (BS '56) for creating the Robert T. Herzog SURF Endowment with a preference for supporting students in the Division of Engineering and Applied Science! Bob has been a long-time friend of SURF.

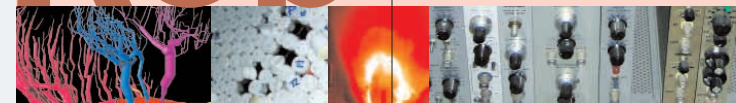
Robert Grogan is the first Herzog SURF Fellow. Rob, a sophomore majoring in electrical engineering, worked this summer with Professor Richard Murray on *Characterizing the Driving Limits of Shock Sensitive Off-Road Race Vehicles as Part of the DARPA Grand Challenge*. Rob is a member of Team Caltech, building an autonomous ground vehicle to traverse a 175-mile route over desert terrain that features natural and man-made obstacles. The route will not be revealed until two hours before the event begins. The team that builds the vehicle that navigates the designated route first and in less than ten hours, wins \$2 million.

Rob says, "The goal of my research is to determine what obstacles Alice, the Team Caltech 2005 Race Vehicle, can traverse and

which must be avoided. I have analyzed the travel and compression capabilities of Alice's suspension system in the California desert and have developed rudimentary limits for the amount of shock and vibration that is acceptable to the vehicle's computer systems. In my research I have determined that Alice's nine-thousand-pound mass and limited footprint will prove to be a challenge for its successful completion of the race course. Whether or not Team Caltech can use this research to optimize Alice's speed commands for varying obstacle strength will determine whether or not the group can bring home victory in October."

**"THE ABILITY TO PARTICIPATE
AS A MEMBER OF THE DARPA
GRAND CHALLENGE RACE TEAM
WAS THE REASON I CHOSE TO
COME TO CALTECH."**

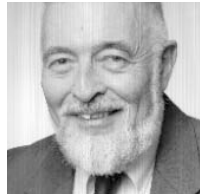
Rob





Members of Team Caltech intently prepare for the DARPA Grand Challenge, a race of 43 robotic vehicles over 175 off-road desert miles. Twenty-one SURF students worked over the summer on Caltech's vehicle, Alice, with high hopes of completing the course in under ten hours and winning the \$2 million prize.

Report of the SURF Administrative Committee



Fred Shair

The SURF Administrative Committee provides faculty oversight of the academic and research aspects of the SURF program. It ensures quality of the program by reviewing students' proposals and making recommendations for SURF awards, maintaining interactions with SURF mentors, and providing counsel to the SURF Director. The AdComm establishes program policy, is responsible for long-range planning, and reviews new programs related to SURF.

We celebrate SURF's 27th program this year with a record 423 participants. While 69% of the fellows are Caltech students, the program attracted strong students from top public and private research universities, liberal arts colleges, and community colleges. Students came from as far as Turkey, Australia, and Hong Kong.

SURF is a microcosm of what it means to be a scientist or engineer. Students, after collaboration with a mentor, write a research proposal, a key component of their SURF applications. A faculty committee reviews the proposals and recommends awards. The program depends upon the strong participation by faculty, postdoctoral scholars, and graduate students. The program succeeds because of the close interaction between students and their mentors and co-mentors.

Though the program is driven and motivated by the students themselves, SURF provides the infrastructure to help connect students with prospective mentors. Program requirements facilitate collaboration and communication among fellows, mentors, and co-mentors. The oral and written reports serve as pedagogical tools to ensure that participants integrate the knowledge gained through the research. The standard for a SURF project is the potential for publication in a refereed journal, and about 20% of SURF students become co-authors, con-

tribute to agency reports, or present their work at professional or undergraduate conferences.

The essence of SURF is the interaction between student and mentor working together on a project of mutual interest. In evaluating applications and proposals, reviewers seek evidence of intellectual engagement by prospective fellows and mentor enthusiasm for collaborating with the student. These elements are strong predictors of a quality research experience.

The Graduate Student Council invited the Student-Faculty Programs staff and AdComm chair to meet with them to discuss their questions and concerns as co-mentors of SURF students. We applaud their initiative to enhance their own mentoring experiences by calling attention to particular issues. Actions have been taken to support and train them to make their experiences rewarding and ultimately to improve the SURF experience for the undergraduates.

We deeply appreciate the participation of the mentors and co-mentors in ensuring that our students have outstanding research experiences. The enthusiastic support of the administration, the faculty, and the staff of the Institute have helped to make SURF one of the premier undergraduate research programs in the country.

SURF Profile

PROFILE OF 2005 SURF CLASS

<i>Division</i>	<i>Total # of Students</i>	<i>CIT Students</i>	<i>Non-CIT Students</i>	<i>Mentors</i>
Biology	61	51	10	34
Chemistry and Chemical Engineering	52	39	13	30
Engineering and Applied Science	107	77	30	46
Geological and Planetary Sciences	22	10	12	16
Humanities and Social Sciences	15	11	4	11
Physics, Math, and Astronomy	61	51	10	40
JPL	83	36	47	52
Off Campus	15	15	0	15
International	7	7	0	3
TOTAL	423	297	126	247

<i>Class Level</i>	<i>Percent</i>
Pre-Freshman	2%
Freshman	21%
Sophomore	31%
Junior	40%
Senior	5%

Women	36%
Minorities	5%
Average GPA	3.45*

* Caltech students only, excluding pre-freshmen and freshmen

Statistics From the 2005 Graduating Class

Total number graduating: 217

Number of SURFers: 140 (65%)

Total number of graduates receiving honors: 102 (47% of the graduating class)

Number of SURFers receiving honors: 81 (79% of the students receiving honors)

Total number of prizes awarded: 114

Number of prizes received by SURF students: 102 (89%)

Allied Programs

The Student-Faculty Programs Office administers an array of undergraduate research programs including the MURF program; the Laser Interferometer Gravitational-Wave Observatory (LIGO) program in the physics department; the NASA Undergraduate Student Research Program (USRP), Space Grant, and Planetary Geology and Geophysics Undergraduate Research Program (PGGURP) at JPL.

When students are admitted to these programs, they may attend all activities planned by the Student-Faculty Programs Office including the Whitney Workshops, weekly seminars, and social and cultural events. The non-Caltech students may live in student housing.

All Student-Faculty Programs have similar requirements. Students must write either a research proposal or a project plan prior to the start of the program. They must conduct their projects for ten weeks, give an oral presentation, and write a technical paper at the conclusion. They receive stipends of \$5000. The total number of students in all SFP programs for 2005 is 561.

SURFing the Dunes



BOOMING DUNES, one of nature's fascinating phenomena—have been the focus of investigation of four generations of SURF students under the guidance of Professors Melany Hunt and Chris Brennen. The question: Why do some sand dunes make sounds variously described as booming, barking, burping, or singing? No one knows, and it is a splendid question for undergraduate researchers to explore!

The phenomenon has been known for many years, and a few papers have been written, some by Caltech faculty. Four years ago a group of students went out to the desert dunes to see if they could hear the sounds, and they returned with a jar of sand that “burped” when it was shaken. Brennen and Hunt became intrigued, and this broadly interdisciplinary research began in earnest. Since there are no grants to support this project, the work has been done on a shoestring budget by undergraduate students, many of them SURFs, in engineering, geology, and other fields.

Much of the research has been done at the Dumont Dunes near Baker, California, and the intrepid Student-Faculty Programs director joined this summer's dune crew—SURFers Natalie Becerra, Daniel Oliver, and Patricio Romano-Pringles; graduate student Nathalie Vriend; high school students Michael Gallaspy and Christopher Lee, and mentor Melany Hunt—on a field trip to measure, record, and sample the sand and to hear the sounds. We left campus at 5 AM, well supplied with water and donuts.

The dunes rise magnificently from the flat, rocky desert floor. The trek from van to dune crest meant climbing a steep hill in hot, deep, fine sand. Everyone worked quickly to get as much data as possible before the day became unbearably hot. Unfortunately, the sampler and a probe broke in the deep sand, and the desert heat overcame the laptop computer. The highlight of the trip was the moment we sat at the top of the dune and, on a signal from Nathalie who was stationed below us to measure the sounds, we scooted down the dune to move the sand to produce the sounds. The eerie sounds of the dune enveloped us. What an amazing experience!

Back on campus in the comfort of an air conditioned conference room, we talked about the project. Over the four years much effort has been put into inventing and adapting equipment to make various measurements of the sand in the dunes. The students are learning a lot about what it takes to engineer new devices to carry out particular tasks!

Patricio, who is a senior this fall, SURFed with Melany Hunt last summer on the dunes project, and he remains interested in the project though he is doing an industrial SURF this summer. He explains the goal is to get a three-dimensional image of the dune under the surface sand. The students have developed or adapted many pieces of equipment, including a device to gather sand samples at various depths in the dune, geophones to measure the horizontal and vertical vibrations, and sieves to determine sand particle size distribution. Last year Patricio and fellow student Ransom Williams built a new conductivity probe to measure the resistance in the sand in order to estimate the water content. These measurements will be compared with weather patterns.

Natalie, a sophomore, likes the project because it is “fun science.” She learned about the project when it was

presented in a freshman class introducing students to the engineering curriculum and research opportunities. This summer she invented a device to transfer sand samples directly into sample jars without spilling and commingling the deep sand with the surface sand. She is now trying to repair the electrode probe. Another aspect of her project involves baking water out of sand samples, but in initial tests she discovered the oven she was using gave her ambiguous results. Another piece of equipment to repair!

Daniel became intrigued with the project when Melany shook jars of sand to demonstrate the sounds. “But I really got interested in this project when we all went to the dunes and experienced the booming. The phenomenon is so cool and very strange. When you are sitting on the dune and riding down, you can feel the dune vibrating, and you are surrounded by the sound being generated,” he says. Dan’s project is to shake the sand on a shaker table at eight times a second to measure the shear rate versus the frequency. He, too, is working on equipment, trying to keep the sand container from leaking, the shaker table from overheating, and the geophones working. At the end of the summer, he was able to take synchronized high speed photography and sound data and is

looking forward to analyzing the data.

Angel Ruiz Angulo, a graduate student, has become an expert in building equipment for the sand dune project, though his thesis research is unrelated. He enjoys working with the undergraduates. “They come with new ideas and new interests,” he says. He has become the expert the students seek when they have questions, especially about equipment and electronics.

Nathalie Vriend is the first graduate student who will get her degree from working on this project. She became fascinated by the work after she read an article about the booming dunes. She likes the interdisciplinary nature of the project that stimulates her curiosity about geophysics and fluids. She says that her involvement will provide continuity from one group of SURF students to the next, and she will be able to use the SURF students’ results to further her thesis research.

Nathalie enjoys working with the undergraduates. “They help keep you sharp,” she says. Her mentoring experience this year has shown her that it is important to give the students the help they need without taking over the work. “Students should be happy,” she observes, and she is careful to compliment them on their successes as well as give them the critical feedback they

need to help them learn. She says that she asks the students lots of questions about what they are doing and what their results mean. Smiling, Nathalie says both Dan and Natalie have done a good job this summer and have gotten results that will advance the project.

Melany adds that it is important to make sure the students don't get too stuck or so frustrated that they cannot move forward. They need to feel they can ask questions. "We—the graduate students and I—can suggest others who might be able to provide the answers to things we don't know, or we can suggest books and other resources. Many times we don't know where to go or what to do next either," she says. But that is part of science, finding the resources you need to proceed. Mentors help students look at things in different and new ways.

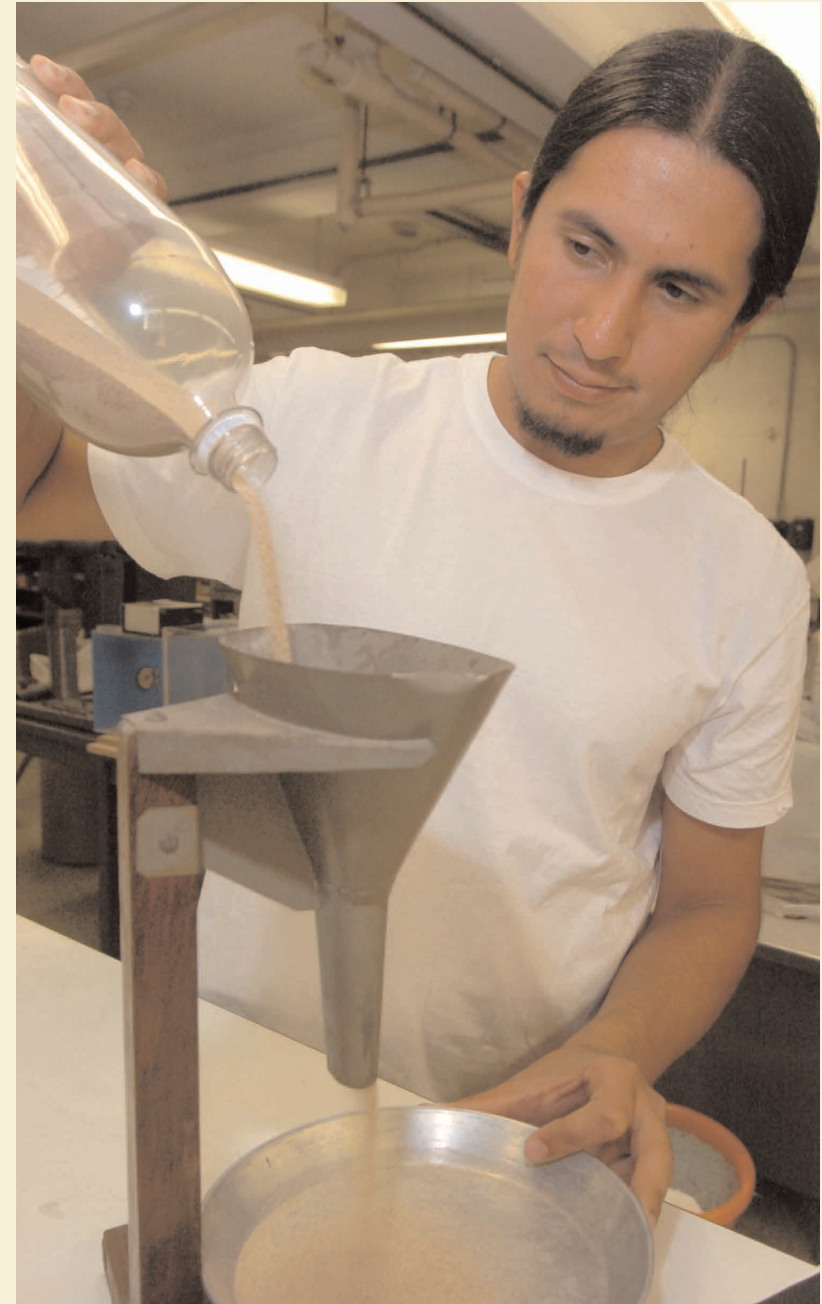
The students agree that SURF has given them good experiences and that they appreciate the willing assistance they get from their mentor and co-mentors. Nathalie, the SURF student, likes the fact that her co-mentor, Nathalie, asks her a lot of questions that help her think more deeply about what she is doing. "She does not take things at face value but wonders what they mean. It propels an idea in interesting ways, makes me think, and

keeps me trying to figure out why," says Natalie.

Patricio hopes to attend graduate school, and SURF helped him make that decision. "I didn't know what research was like before I started," he says. "I think research is just as important as academics. Through courses you learn a lot of theory, but it is important to know how to apply it."

Dan comments that research has benefits and drawbacks. He is often frustrated because he has had to spend a lot of time working on equipment and hasn't gotten any data yet. But, he says, "it is cool to be working on something that nobody else knows. No one knows what the shear rate versus the frequency is." He likes design and is thinking about working for an aerospace company after he graduates.

Natalie hopes to continue working on the booming dune project. She enjoys the chance to explore new things. She admits that she was stressed out during the academic year with the heavy freshman course load, but now she is putting her effort into something different, applying knowledge instead of just studying from books. "It feels more real," she says. "I am really happy to have this opportunity. It adds a lot to an awesome education."

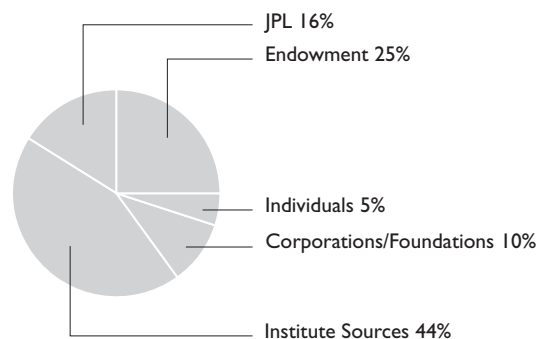


Funding SURF

Each SURF student receives a stipend of \$5000 for the ten-week summer period, a total budget of over \$2 million. Most of the funds are raised annually from a variety of sources including gifts from individuals; foundations and corporations; faculty grants and other Institute sources; and NASA funds (for students working with mentors at JPL).

The Student-Faculty Programs Office, in partnership with the Development Office, raises funds to support Caltech SURF students collaborating with faculty on campus or at other universities. Typically mentors pay half the stipend, and funds raised from private external sources—individuals, corporations and foundations, and the endowment—are used as matching funds.

2005 SURF Funding



SURF depends upon the generosity of its many friends for annual gifts or for contributions to the SURF endowment to build a robust financial base to ensure that Caltech students continue to have the opportunity to engage in research with faculty. We thank the many donors who have supported SURF 2005!

The Campaign for SURF

The administration designated SURF as one of the priorities in the current capital campaign with a goal of increasing the SURF endowment by \$10 million. This significant addition to the endowment will ensure the future of the program and will provide Caltech students with the unparalleled opportunities to engage in research at the frontiers of knowledge under the coaching of experienced mentors.

Individuals or groups may establish an endowment for \$125,000 to support one student annually in perpetuity and may be named as the donor designates. There are several ways to establish endowments—they may be paid in full at creation, given in installments over a period of three to five years, or specified in the donor's estate plans.

Endowment donors receive special benefits. Each year a student will be selected to bear the endowment name, and the contributor will receive a letter introducing the student and describing the project. If they choose, donors may have the opportunity to meet the students supported by their gifts, and they often receive

letters of appreciation from “their” students. Donors are invited to attend SURF Seminar Day to hear the student's final oral presentation. The Student-Faculty Programs Office notifies endowment contributors when students they have supported win special recognitions or publish papers. Endowment contributors can be proud of the investment they have made in the future of Caltech's bright and talented students, and they gain the personal satisfaction from playing an important part in the formation of young people, many of whom will make significant contributions to the nation and the world.

Annual Gifts

We deeply appreciate the gifts from the friends of SURF who make donations in all amounts to support our students in the undergraduate research enterprise. We depend upon these contributions to help us build a robust financial foundation for SURF each year. Each gift is important!

Gifts may now be given to SURF online through the secure Alumni Fund website. Log onto <http://www.surf.caltech.edu> and click on Making a Donation for the link. You do not have to be a Caltech alumnus to use this site! You may also mail contributions to the SURF Office, California Institute of Technology, 139-74, Pasadena, CA 91125.

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SURF depends upon the assistance of many individuals to review students' proposals and submissions for the Marcella and Joel Bonsall Prize for technical writing, serve as session chairs on SURF Seminar Day, and judge presentations for the Doris S. Perpall prize for excellent oral communication. We thank the following people for their help with SURF 2005:

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SURF 2005 Summer Program

Caltech Wednesday Seminars

This year, nine seminars were given on Wednesdays at noon by members of the Caltech faculty, covering areas of their research. The speakers and topics were:

DAVID BALTIMORE

Nobel laureate; President; Professor of Biology
The Low-Down on Stem Cells

COLIN F. CAMERER

Rea A. and Lela G. Axline Professor of Business Economics
Behavioral Game Theory: The Psychology of Strategic Thinking

LYNNE HILLENBRAND

Assistant Professor of Astronomy
Debris Around Young Suns

MELANY L. HUNT

Professor of Mechanical Engineering
Booming Dunes and Other Granular Flows

DIANNE NEWMAN

Clare Boothe Luce Associate Professor of Geobiology and Environmental Science and Engineering Investigator, Howard Hughes Medical Institute
What is Molecular Geobiology?

ERIN SCHUMAN

Professor of Biology
Associate Investigator, Howard Hughes Medical Institute
Protein Dynamics at Neuronal Synapses

CHRISTINA SMOLKE

Assistant Professor of Chemical Engineering
Programmable Molecular Switches and Sensors: Applications in Intelligent Therapeutics, Metabolic Engineering, and Biosensors

PAUL W. STERNBERG

Thomas Hunt Morgan Professor of Biology
Investigator, Howard Hughes Medical Institute
Genomic Control of Cell and Organism Behavior: From Circuit Analysis to Circuit Design

EDWARD C. STONE

David Morrisroe Professor of Physics
Voyager Project Manager
Voyager's Journey to the Edge of Interstellar Space

JPL Friday Seminars

Each Friday, members of the JPL staff presented talks to SURF, MURE, USRP, PGGURP, and Space Grant students. Speakers and topics this year were:

TIBOR BALINT

Senior Engineer
Nuclear Power for Solar System Exploration

BONNIE J. BURATTI

Lead Scientist, Asteroids, Comets, and Satellites
Icy Oddballs in Space: The Satellites of Saturn as Seen by the Cassini Spacecraft

DAVID W. CURKENDALL

Manager, Earth Systems Information Technology Office
The Explosion of Geographical Data and Its Uses

LESLIE J. DEUTSCH

Architecture and Strategic Planning
Interplanetary Network Directorate
The Interplanetary Network: The Future of Deep Space Communications

MAGGIE GLASSCOE

Technical Staff, Solid Earth Group
Living on a Restless Planet: Causes and Effects of Earthquakes and Tsunami

FRED HADAEGH

Senior Research Scientist
Flying in Formation: Challenges and Opportunities

ALBERT F. HALDEMANN

Mars Exploration Rover Deputy Project Scientist
The Science From "Spirit" and "Opportunity"

EDWARD A. HIRST

Genesis Mission Manager
Genesis: Setting the Stage for Future Sample Return

ROSALY M. LOPES

Lead Scientist, Geophysics and Planetary Geosciences Group
Investigation Scientist, Cassini Titan Radar Mapper
Volcanoes on Earth, Io, and Titan

The William Whitney Workshops

The purpose of the workshops is to help students make short-term educational and career decisions in the context of longer-term life and career goals.

INVENTING YOUR FUTURE: WHAT ARE YOUR OPTIONS?

Dr. William Whitney
Deputy Manager, Education Office, JPL
Dr. Jerry Houser
Director, Career Development Center, Caltech

COMMUNICATION IN CAREERS

Ms. Carolyn Ash
Director, Student-Faculty Programs
Dr. William Whitney
Deputy Manager, Education Office, JPL

SCIENTISTS AS SPEAKERS

Dr. Jonas Peters
Associate Professor of Chemistry

THE ART OF GRIP AND GRIN: AVOID EMBARRASSMENT, BUILD RELATIONSHIPS, AND GET AHEAD WITH GOOD MANNERS!

Ms. Amy Malak
*Work/Life Programs Coordinator, Staff and Faculty
Consultation Center*

WHAT'S YOUR PERSONALITY TYPE?

Dr. Jerry Houser

Director, Career Development Center, Caltech

Ms. Joni Watanabe Tsuji

Career Development Center

Ms. Angela Wood

Career Development Center

Ms. Yvonne Banzali

Career Development Center

GRADUATE SCHOOL: THE NUTS AND BOLTS OF THE APPLICATION PROCESS

Ms. Joni Watanabe Tsuji

Career Development Center

Special Events

Former astronaut Dr. Robert A. Parker of the NASA Management Office at JPL presented a talk on the Caltech campus called "So You Want to Be an Astronaut?" This was a popular event which brought in a full room of students and sparked a long and lively discussion.

Dr. and Mrs. George Boone again sponsored SURF students for a behind-the-scenes view of The Huntington Library, Art Collections, and Botanical Gardens. Later, the Boones hosted students to a reception at their residence for more art in their backyard-turned-garden of sculptures that range from life-size to the minute.

The JPL Mission Life-Cycle Tour gave participants a glimpse of the phases of development of the Mars Exploration Rover and the Cassini Saturn Orbiter, beginning with conceptual design, continuing through technology development, component fabrication, component and system assembly and testing, and concluding with mission operations. We thank Dr. William Whitney, Dr. Art Hammon, and Mr. Richard Alvidrez for organizing and conducting the tour.

Communication Program

Awards and Prizes

DORIS S. PERPALL SURF SPEAKING COMPETITION

Robert C. Perpall (BS '52, MS '56) endowed a prize in memory of his late wife, Doris Perpall. The award encourages students to prepare excellent SURF presentations. Last year's winners were:

Daniel Koslover	1st Prize
Priya Kollipara	2nd Prize
Haomiao Huang	3rd Prize

Conferences

SURF SEMINAR DAY was held October 15, 2005, on the Caltech campus. The SURF program requires students to give either an oral or poster presentation to an audience of peers, faculty, mentors, alumni, donors, families, and prospective students in parallel sessions.

SOUTHERN CALIFORNIA CONFERENCE ON UNDERGRADUATE RESEARCH (SCCUR) is a one-day

conference held each November on the campus of a college or university in the greater Los Angeles area. Its purpose is to provide a forum for the presentation and discussion of the best research, scholarship, and creative work of undergraduates in the region, and thus to encourage excellence in undergraduate achievement generally. SCCUR draws over 500 participants. Last year's conference took place at the campus of Whittier College, and Caltech presenters were:

Carl Chin, Richard Eager, Daniel Fu, Issac Garcia-Muñoz, Hung Nong, Tharathorn Rimchala, Vera te Velde, Vivian U

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