



SURF **2010**

Annual Report
Summer Undergraduate
Research Fellowships

California Institute of Technology

Dear Friends of SURF,

The Summer Undergraduate Research Fellowships (SURF) program stands as one of the most compelling examples of Caltech exceptionalism. SURF gives undergraduate students two unparalleled opportunities: (1) real access to many of the finest research facilities in the world and (2) personal mentoring from global leaders in their respective fields. When these two components meet in the bright young minds of Caltech SURFers, you can almost feel the rumblings of the next vanguard of U.S. scientists and engineers taking off. SURF is also a global endeavor. Eleven Caltech students SURFed abroad this year, and we welcomed 23 students from foreign institutions to campus. These associations introduce SURFers to the spirit of international collaboration that is now the norm in cutting-edge science.

Because SURF is based on the same grant model of research funding that applies to even the most senior faculty, students gain invaluable experience in seeing a project through from proposal writing to presentation of results. The research engaged in by SURFers might also spark a new investigative passion, start students down an exciting career path, or make a positive impact on society. In recent years, SURFers have helped develop radical new wind turbine technology, proposed a groundbreaking treatment for HIV/AIDS, and precisely measured the carbon footprint of Caltech.

There was no shortage of standout SURF projects this summer as well. Caltech senior Lucas Hartsough and teammates, under the mentorship of Dr. Richard Murray, made significant gains for our school's iGEM team, which will participate in the world's premier synthetic biology competition later this year. At JPL, Caltech sophomore Tong Lu worked with Dr. Xenia

Amashukeli (SURF '86) to study endospore germination in conditions simulated to match the Jupiter moon of Europa, which many scientists believe may have an ocean capable of sustaining primitive life.

A record number of SURFers—425 to be exact, including 73 students from other colleges—participated in SURF 2010, and I would like to congratulate all the members of SURF's extended family who made this summer so successful. Thanks to Gary Stupian and the SURF Board, as well as Harry Gray and the SURF Administrative Committee, for their invaluable leadership. Thanks to Candace Rypisi and her team for helping make SURF the envy of research institutions around the world. Thanks to the 225 mentors who took time out of their busy summers to direct the boundless energy of SURFers down the most illuminating path.

Finally, thanks to all of the friends and alumni whose donations help make SURF financially possible during these difficult economic times. And for the first time ever, a 2010 SURFer was supported by generous gifts from the staff of the Office of Development and Institute Relations. I applaud all of your tremendous generosity and remind you that it's not too early to give for next year—SURF 2011 is only 7 months away! Helping support the next generation of innovators is truly an investment in the future.

SURF's you right!

Jean-Lou Chameau
President
California Institute of Technology



FROM THE SURF BOARD

Gary Stupian, *Chair*

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.

Congratulations to all the 2010 SURF fellows and their mentors on another successful summer! Almost every year since 1979 the SURF program has grown, providing more and more research opportunities to eager young scholars than the year before. This year was no different. The total summer class—comprised of over 700 students from SURF, MURF, Amgen Scholars, Space Grant, and several other research programs—marks the largest group of summer undergraduate researchers ever at Caltech.

It may be hard to believe but a third of the living Caltech undergraduate alumni have participated in SURF! Inside this report you'll hear about SURF alums such as Ken Libbrecht, John Dabiri, and John Johnson who now are on the Caltech faculty. Others, such as Jim Jensen, are professors at other colleges and universities. SURF has played an important role in their lives and now they, along with all the other SURF alums, are critical to the program's ongoing success. Each year dozens of alumni serve as session

chairs and judges at SURF Seminar Day. Alumni also host lunches and dinners with students over the summer with the goal of introducing them to a variety of academic and career paths. SURF also relies on the financial generosity of our alumni in order to support the growing number of student scholars.

This past year the Alumni Relations committee of the SURF Board, along with representatives from the Alumni Association and the Gnome Club, met to discuss ways to increase alumni participation in SURF. We are working to increase outreach and participation among SURF alumni living in Southern California. If you'd like to get involved, please contact the office or the Board.

On behalf of the Board, I'd like to thank Gabrielle Adelman (SURF '85, '86), Jim Cutts, and Sam Vodopia for their outstanding service to SURF. They are each rotating off the Board after serving two three-year terms. We so appreciate their dedication and commitment to the program and the students. We are pleased that Carol Carmichael and Tom Tisch have been re-elected for second terms. And I'd like to extend a warm welcome to three newly elected members: John Davis (SURF '91), Paula Grunthaner, and William Deverell. Welcome aboard.

Thank you again for a successful 2010.



Dedication

SURF 2010 was dedicated to Bob and Toni Perpall, in recognition of their outstanding contributions to the SURF program. Bob Perpall (BS '52 ME, MS '56 ME) (Fleming) has been associated with SURF since 1989. He is a Life Member of the SURF Board and served as its Chair from 1999-2001. In 1994, Bob endowed the Doris S. Perpall SURF Speaking Award in memory of his first wife as an incentive for students to prepare excellent oral presentations. Toni served on the SURF Board from 1997-2003. Together they created the Toni and Bob Perpall SURF Endowment in 2006, which provides annual support for a SURF Fellow in perpetuity. Both Bob and Toni are tireless advocates for Caltech, SURF, and our students, and we are proud to dedicate SURF 2010 in their honor!

SURF Dedictees

1985	Dr. Ernest Swift
1986	Dr. Lee A. DuBridg
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 M. 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
2006	Lew and Edie Wasserman
2007	Carolyn A. Ash
2008	David L. Goodstein
2009	Carl and Shirley Larson
2010	Bob and Toni Perpall

FROM THE SURF AdComm

Harry Gray, *Chair*

In the 2011 edition of *U.S. News and World Report's* annual America's Best Colleges survey, Caltech was ranked seventh. Caltech was described as "a school with outstanding undergraduate research." This, of course, comes as no shock to those of us involved with SURF! In fact, in its 32 years, SURF has become a core part of the Caltech undergraduate experience.

This year the SURF Administrative Committee continued to focus on Caltech's reaccreditation process. As I reported last year, undergraduate research was one of three themes the Institute decided to study as part of the accreditation review. During the first phase of the review, we studied Caltech's unique capacity to provide outstanding research opportunities to our students. Furthermore, we established student learning outcomes associated with one's participation in undergraduate research.

The second phase of the accreditation review focused on better understanding the educational effectiveness of our undergraduate research program. As part of the 2009 alumni survey, several questions were asked about the impact of undergraduate research. Alumni respondents who participated in undergraduate research indicated that to a "considerable extent" or to a "very great extent" their undergraduate research experience increased their understanding of the research process in their field; provided a connection with a Caltech faculty member; influenced the direction of their academic and/or career path after graduation; and improved their ability to integrate theory and practice. To a lesser extent, they indicated that research helped to improve their communication skills.

For alumni who graduated between 2004 and 2008, 70% agreed that research was an "integral part of their undergraduate education." This percentage is significantly higher than for alumni who graduated



30 years prior. (Less than half of the alumni from the 1970s or 1980s agreed that research was integral to their education.)

On April Fool's Day, the AdComm met with the accreditation visiting committee! It was also the day SURF awarded the largest class of SURFers to date! The visit went well and just recently Caltech's accreditation was renewed. In a final report the accreditation visiting team commended Caltech for "protecting" SURF during these difficult budget times. They also noted the "outstanding commitment" on the part of the faculty to undergraduate research. The committee also made several recommendations for continued improvement. They include:

- > Continue faculty and student discussions on how to provide research to all undergraduates desiring a research experience, especially those in their first year on campus.
- > Explore strategies for making it easier for students to match with an appropriate mentor and research project
- > Find ways to tap into the faculty mentoring expertise to better train and support postdoctoral scholars and graduate student co-mentors
- > Continue to focus on strengthening the written and oral communication skills of all students
- > Formalize assessment efforts

All in all the accreditation process highlighted the strengths of the SURF program. Many thanks to all of the faculty, administrators, staff, co-mentors, alumni, and donors whose hard work and dedication make it so!



SURFIN' SAFARI



Reprinted from Caltech's *Engineering and Science Magazine*, Summer 2010

“Thanks to the SURF program, I was hooked instantly by the open-ended nature of research, by the collaboration ... and by the small victories and seemingly enormous challenges.”



Thirty-one years ago, Caltech junior Ken Libbrecht was one of 17 [sic] students in the Institute's new Summer Undergraduate Research Fellowships program, or SURF, as it quickly came to be known. At the time a unique program, SURF offered undergraduates the opportunity to pursue original, hands-on research in close collaboration with faculty mentors. The students could choose the area in which to work—a junior committed to chemistry might spend 10 weeks studying earthquakes, or a sophomore undecided about whether she really wanted a post-college career in the laboratory might have a better idea about it after 10 weeks of communing with a collection of petri dishes.

Whatever the neophyte researchers elected to do, the whole idea was to give them a sense of how research actually works, from that first crucial step of submitting a proposal to the final formidable one of writing a research paper. Each SURFer received a summer stipend, came to know their faculty advis-

ers as colleagues and friends, and went on to present their research at a SURF symposium modeled on professional conferences. By the time they left Caltech, several had also put their names to one or more published articles while they were still undergraduates. Above all, they had gained a firsthand appreciation of the research experience.

Libbrecht, a physics student, spent his SURF summer working with fellow physicist and Caltech professor Steve Koonin on an aspect of nuclear theory, which resulted in a paper in the highly regarded *Physical Review Letters*. Now himself a Caltech physics professor for more than a quarter century, Libbrecht is still involved with SURF. But these days, he's the mentor.

Although the basic elements of SURF remain the same, quite a bit has changed since 1979, when 17 students worked with 16 mentors [sic]. This year 431 students are working with 261 mentors. The SURFers include 53 undergrads from other schools who have come to Caltech to do research; 46 who are working with scientists at Pasadena's world-renowned Jet Propulsion Laboratory; and a number of Techers who are SURFing offsite at other university campuses, national laboratories, or high-tech R&D companies.

After all this time, SURF boasts many alumni, including current Caltech professors. Two of them, John Dabiri and John Johnson,



were both undergraduates at other universities when they took part in SURF, and both say the experience had a significant impact on their careers.

Back in 2000 Dabiri was an undergrad at Princeton, "and Caltech wasn't on my radar at all," he says. "I told one of my professors that I was interested in doing summer research in experimental fluid mechanics, and he suggested the names of a few professors around the U.S., including Mory Gharib, a Caltech professor in aeronautics. I had never been to California (or on a plane!), so this seemed like a good excuse."

Dabiri enjoyed that SURF summer so much that he came back to Caltech for a PhD, with Gharib as his thesis advisor. Now an associate professor of aeronautics and bioengineering, Dabiri says, "My SURF involved measurements of jellyfish swimming. I wasn't thrilled when I first heard about the project because I didn't think biology could be rigorous. But I fell in love with biological fluid mechanics, and I have been doing it ever since."

Thinking he might want to attend Caltech as a graduate student, Johnson, then an undergrad at the University of Missouri-Rolla, saw SURF as "an opportunity to learn more about life at Caltech, build up research experience, and hopefully get a letter of recommendation from a Caltech prof."

Johnson, who did his SURF with Caltech's Laser Interferometer Gravitational-Wave Observatory (LIGO) research team, has since moved on to observational astronomy, identifying and studying planets beyond our solar system. He credits his SURF experience with helping him realize that he'd rather work in a smaller research group than in a large consortium. "It taught me that I love research, but that I needed a research question of my own."

Dabiri adds, "I think SURF can be eye-opening for students who are used to classroom learning, where someone else has already solved all of the questions. In research they get to experience the frustration and exhilaration of learning something no one else knows. That certainly was my experience."

When Libbrecht returned to Caltech after receiving his PhD at Princeton, he had no doubt that he wanted to mentor SURF students himself, a sentiment echoed by Dabiri and Johnson. Still, Libbrecht acknowledges that the experience can be a bit bitter-sweet. Johnson was his SURF student back in '99, and, says Libbrecht, "A person feels old when your SURF students have their own SURF students!"

This article originally appeared online in *Caltech Today* the week of July 13. A few days later, we received an email from Jim Morgan, Goldberger Professor of Environmental Engineering Science, Emeritus. He was curious as to whether his former student Jim Jensen had been one of those original 17 [sic] SURFers in 1979. Indeed he had. The two men have kept in touch over the years, and it turns out that both remember that first SURF summer.

"Great guy all around," says Jim Morgan of Jim Jensen. "I still remember Jim playing in the pep band. . . ." As to the importance of SURF, Morgan opines, "I believe that SURF was instrumental in stimulating his interest in a future career."

Jensen agrees, saying, "Before my SURF experience, I had no idea what research entailed. I was hooked instantly by the open-ended nature of research, by the collaboration with Jim and his graduate students, and by the small victories and seemingly enormous challenges."

Jensen now says that one of his biggest pleasures—as academic director of the University at Buffalo's Research Exploration Academy and professor in the department of civil, structural, and environmental engineering—is having "the privilege of introducing undergraduates to the joy of research."

"As I work with undergrads in our research seminars, I often think back to those sunny summer days in Keck Lab and ask, 'What would Jim Morgan do to inspire them?'"

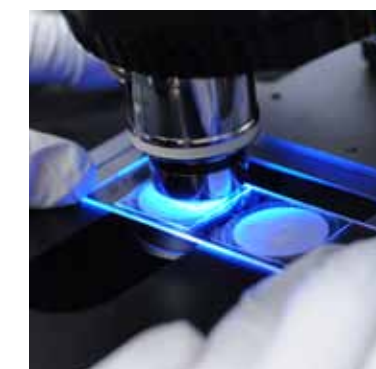
Jensen's 1979 SURF project looked at how metals behaved in the presence of analogs of naturally occurring organic matter. After graduating from Caltech in 1980, he went on to receive his PhD at the

University of North Carolina at Chapel Hill, continuing to work on naturally occurring organics. First as a graduate student and then as a young professor, he was elated to meet some of the people who wrote the papers that had inspired his SURF project. "SURF taught me about the community of scholars I was about to join."

After that memorable summer of '79 "elbow-deep in glassware and chemicals," Jensen enjoyed another first—becoming one of the first three SURF students to make a presentation to Caltech's Board of Trustees. "The trustees were gracious and pretended not to notice my shaking knees," he says. In hindsight, he says, that SURF summer, complete with Board presentation, gave him the confidence and enthusiasm to think seriously about pursuing his own research and teaching career.

It's been a career marked by a long line of Jensen's own graduate students, numerous awards and scientific papers, and two books. And now he's working on his third: the fourth edition of *Aquatic Chemistry* by Werner Stumm and—yes—James J. Morgan. The book remains the definitive resource on the essential concepts of natural water chemistry—in fact, it's considered by many to be the field's bible. "I was deeply humbled when Jim approached me about revising the book that he cowrote. I never dreamed that I'd be writing the fourth edition of a book that we used in his class all those years ago," says Jensen.

Adds Morgan, "And only thirty years gone by."
—Paula DiConti



JORDAN THERIOT ON SURFING IN LOUISIANA

PART [1]

Development and Institute Relations Helps an Undergrad Go SURFing

by Kathy Svitil

This summer, junior chemistry student Jordan Theriot is SURFing far from Caltech, but on familiar ground, in her home state of Louisiana. Jordan's return to her roots was made possible by an unusual unrestricted Summer Undergraduate Research Fellowship funded through a grassroots effort by the members of Caltech's Office of Development and Institute Relations. Over the next few months, Jordan will be sharing her experiences in a Louisiana State University inorganic chemistry laboratory headed by former Caltech graduate student Andrew Maverick (PhD '82), and her journey toward becoming a full-time research scientist.



What have you been doing?

I have a lot of reasons for doing a SURF in Baton Rouge, Louisiana. I'm a New Orleans native, and like most teenagers, spent all of high school dreaming of the day I'd leave my home state. After two years in Pasadena, I have to admit, I like California, but I absolutely love Louisiana. The homesickness started to get to me my sophomore year, and by the time SURF application season came around, my mind was so stuck on the smell of muffalettas and shrieks of, "How ya doin', dahlin?!" that I just couldn't help myself.

I chose LSU specifically because almost all of my high school friends are here, but also because of something a little more personal. It's a question we all think about as Techers. What if we had chosen a different path? What if we had gone to a school with 30,000 students, 250 buildings, and 20 different varsity teams? What would it be like? I'm really here to answer those questions for myself.

I moved into a house with three fellow alumni from my high school—all close friends—two dogs, and two cats. It's full and busy, but in a completely different way from the Caltech houses. It's really my first taste of adulthood: writing rent checks, grocery shopping, and endless amounts of dishwashing. I'm actually sort of enjoying the newfound responsibilities. Not that pretending to be adults has detracted in any way from us behaving like we are still all in high school together. We've dyed our hair, caught up on all the gossip, and spent hours on end trying to learn the dances from Lady Gaga videos.

What has your SURF experience been like so far?

I had absolutely no idea what to expect from my lab work. All I knew was that Professor Andrew Maverick came highly recommended by both my advisor, Harry Gray, and my previous SURF mentor. As Harry put it, "When it comes to being a mentor, there's no better choice than Andy." As usual, Harry was right.

If I have one regret about my previous research experience, it's that I never asked enough questions. I was always too afraid to be wrong, and would end up making costly mistakes. This year, my goal is to get over that attitude. I knew a great mentor could help make that happen.

My goal quickly became more of a necessity once I arrived. During my last SURF, I worked side-by-side with a grad student on his project, and I arrived at LSU expecting the same. That wasn't what I found. My project was covering some new ground for the group, and as with all new projects, stage one is paper reading. I sat down to a hefty stack of articles. The more I read, the more I realized I didn't know about inorganic chemistry. The more I realized I didn't know about inorganic chemistry, the more flustered I got. The more flustered I got, the more indecisive I became. And the more indecisive I got, the fewer ideas I had.

After about three days of sitting at a standstill, with not a clue as to how to make the first step towards the target molecule, I started to ask questions. A lot of questions.

We have a small group. There's the professor, one grad student, one postdoc, and me. Because of this, everyone has taken a part in getting me educated. It started with Chandi, the postdoc: "But how do I even know a reaction is working?" followed by Jackson, the grad student: "How do I use this machine? And this one? And where can I find this? And this?", and finally Dr. Maverick, who has patiently tapped out pages of responses to the dozens of emails I have sent to him in my short time here. I've been so grateful for everyone's patience with me.

It's easy to see why folks are drawn to this field. The reactions are quick and beautiful. Entries in my lab notebook read something like, "A lime-green solution of nickel nitrate was slowly dripped into the clear yellow solution containing the ligand. During this time, the reaction mixture turned pink, then dark purple, then a light purple precipitate formed." How could you not love that?

Is it what you expected?

My research isn't anything like I expected. I've been given far more freedom to explore than ever before, and to be honest, it's a weighty responsibility for someone so inexperienced. Fortunately, the environment in the lab is perfect for generating ideas. Because we're such a small group, everyone is familiar with each other's work, and so the lab is full of drawings, discussions, and good advice.

Although we do SURF for the research, the program's greatest value is often the opportunity to find out what it's like to be a full-time researcher, or even more relevant to us, to be a graduate student. How better to make such a discovery than to be allowed to design my experiments? Never before have I spent so much time preparing, planning, and seeking advice. And I realize that's how it should have been all along, because as an undergrad, I'm here to find out what it's really like to work in a particular branch of chemistry: success, failure, and all that's in between.

As for my personal life, I've been surprised too. When you're at Caltech, you start to get weighed

down by the feeling that you're working so much harder than everyone else you've ever known. While we might be able to make that argument academically, life for an LSU student is stressful in ways I wouldn't have even begun to imagine. Just about everyone has a job, and not just working the desk at the school library (no offense, library workers). They're baristas and waitresses and clerks. Isabella, my best friend from high school and one of my roommates, works at a vet clinic performing surgeries! Add in finding housing, cooking meals, and trying to unclog the vacuum cleaner every other week, and it's amazing anyone finds time to relax.

That said, it's been so much fun getting reacquainted with everyone after two years away. We've all made steps towards becoming the people we want to be. Maybe I'm standing in the kitchen cooking dinner, and we're all shooting the breeze, just like always, but then the dog starts scratching and Isabella begins calculating the proper anti-histamine dosage for a canine of his weight, and I'm just amazed. We're the same people we were back in high school, but we're not some group of teenagers anymore. We've become chemists, a vet-to-be, and computer scientists, and we're so much happier for it.



What have you learned?

Now that I've got the label "junior" over my head, it's beginning to dawn on me that sooner or later, I'm going to have to pick an area of chemistry to pursue. With every new chemistry class I take, I get more and more nervous about that decision because I've yet to find an area of chemistry I don't like. Should I continue to sample more subjects or is that just a waste of time? Working in a supramolecular lab has been wonderfully reassuring in that sense. The work is so interdisciplinary!

With respect to discovering the differences between Caltech and a place like LSU, I'm going to have to call a "grass is always greener on the other side" argument. While I spent the last two years wondering what it would be like to spend my Sundays watching football in Tiger Stadium, cheering "Geaux Tigers!" alongside 90,000 others, my friends were wondering what it would be like to spend their weekends building Interhovse, shouting out math jokes to their fellow housemates. We've decided to split the difference by spending the evenings sharing our best stories.

I'm also realizing that, despite attending completely different colleges in two very different parts of the country, all four of us are dealing with very much the same summertime struggles. We're all living poor, trying to make use of our vacations to rack up both savings and job experience. We're all starting to freak out about the future. It seems like we just graduated from high school together, but we're stressing out over GREs, majors, minors, grad school, vet school, and job opportunities. We have no clue what we want—we just know we want everything.

As for me, I'm learning that no matter how far my Caltech experience takes me, no matter how many years may pass, I want these friends to always be part of my life. I want Louisiana to always be a part of my life. This is what summer is supposed to feel like. This is what coming home feels like.

PART [2] High Fives From A Strong Caltech Network

by Mike Rogers

During her recent Summer Undergraduate Research Fellowship (SURF) project, Caltech junior Jordan Theriot received a hands-on education about the technical challenges of conducting high-level chemistry experiments. But the occasional hurdles that she encountered in her research were more than offset by her discovery that Caltech has a worldwide community of influential investigators and that, even as an undergrad, she is considered part of that community. She was treated as a colleague and not a trainee, and when her research wasn't going as well as she had hoped, she drew support from the Caltech network.

Caltech's SURF program gives undergraduates the opportunity to work with seasoned investigators on 10-week research projects. Instead of staying on the Caltech campus as she had for her 2009 SURF summer, Theriot, who grew up in the New Orleans area, wanted to be close to home this year.

Getting her wish turned out to be easier than she had imagined, and it gave Jordan her first glimpse of the Caltech network in action. In late 2009, Theriot, a chemistry major, met with her advisor, Harry Gray, the Beckman Professor of Chemistry and founding director of Caltech's Beckman Institute. When she told him that she really hoped to do a SURF project in Louisiana, Gray picked up the phone and called LSU, where one of his former graduate students, Andy Maverick (PhD '82), now chairs the chemistry department.

"That was it," Jordan recalls. "Done. And then when I got to LSU there were so many other Caltech alums in chemistry, including crystallographer Frank Fronczek (PhD '75). The point is, Caltech's influence is really wide."

The Caltech network also came through with financial support for Jordan's fellowship. Her experience was made possible by an unrestricted SURF funded by the staff of Caltech's Office of Development and Institute Relations (DIR). While individual staff members have funded SURFs in the past, this was the first time that a group of staffers pooled their resources to fund a summer fellowship, according to the SURF office. "It meant a great deal to me that funds for my SURF came from Caltech's DIR staff," Jordan says. "It showed me that the Caltech community extends beyond faculty, students, and alumni. That was inspiring."

At LSU, the Maverick lab focuses on building large framework molecules, which have applications in hydrogen gas storage, catalysis, and drug delivery. "It's like building a scaffolding on a molecular level," Theriot says. "You're adjusting molecules to give them a certain purpose—to make them chemically active."

Her assignment for the summer was to build one of these molecules, which proved to be easier said than done. "This was the first time that I was invited to design my own experiments," Theriot says. "That sounds great, but it was really quite terrifying. I spent my first three days there frozen at my desk. I didn't even know the first step to take. Then I sent Dr. Maverick an email with at least a dozen questions, like, 'What is the first step? How do I know if it's even working? What's good? What's bad?' And he typed out four pages of response and sent it to his entire group, saying, 'I think the whole group could benefit from a refresher on this.'

"SURF is hard, because it lasts only 10 weeks," Theriot adds. "Nothing takes 10 weeks in science. So there's a lot of pressure when you're doing a SURF to get results quickly. And even in week nine,

when I hadn't gotten any positive results yet, Andy was very encouraging. I think he really cared more about me developing as a chemist over the summer than developing his research."

It was during that ninth week that she finally produced a potentially useful molecular structure. She ran out the door to Maverick's office.

"I asked his secretary, 'Is Dr. Maverick available for a high five?' So she phoned him, and then said, 'Yeah, he is. Go in.' And I walked in, and Andy Maverick, who is definitely over six feet tall, was standing on top of his office chair, holding up his hand. When I asked him what he was doing, he said, 'I wanted to give you a really high high five.' That was a good moment."

Maverick says that after Jordan's original setbacks, she accomplished a great deal in a short time. "Jordan didn't solve our problem completely, but she made a couple of new compounds that are on the path to what we are after," he says. "Jordan is a very sharp student and on her way to being an excellent scientist. I can hardly wait to hear about her next breakthroughs!"



Back on the Caltech campus, Jordan says that she is eager to resume her studies and research in chemistry. Theriot's summer wasn't all spent in the lab. One of the reasons she wanted to be at LSU was to hang out with her old high-school friends in Baton Rouge. "My two years at Caltech were the only time that I had ever missed Mardi Gras," Theriot says. "I was homesick." And although she enjoyed the region's gastronomic delights, including po-boys, and the country and western karaoke, she says that she was ready to resume her studies at Caltech.

"I truly enjoyed LSU, but I was glad to return to Caltech," she says. "Until this summer, I never realized that the ability to walk up to my professor after class is unusual. I never realized that having an academic advisor who knows who I am is unusual. Something about being here reminds me that there's a grander goal.

"When I'm here, I feel like I'm part of the discipline," Theriot says of Caltech. "I'm a chemist here. I'm in training for something real. There are so many opportunities to develop as a scientist here. I get to work closely with professors and graduate students and I know what I'm getting into and where I'm going."

And as she learned this summer, when a Caltech student ventures away from campus, the Institute goes with her. "People already had high expectations just by virtue of the fact that I went to Caltech. Nobody asked me if I had overloaded with courses every term. Nobody asked for my GPA. People assumed something great about me. To walk around with that feeling was really very uplifting. It definitely got me through the harder times."





SPOTLIGHT ON

MING-CHUNG CHU

SURF Alum, Mentor, and Friend

Dr. Ming-chung Chu (SURF '82), Professor of Physics at The Chinese University of Hong Kong (CUHK), is no stranger to Caltech or to SURF.

Dr. Chu spent most of the 1980s and 1990s at Caltech—as an undergraduate, graduate student, and senior research fellow. In 1983, he completed his BS in physics and in 1987 received a PhD in physics under the guidance of Steve Koonin. As a Richter Scholar in 1982, he SURFed with then Caltech professor, John LoSecco.

In 2002, Ming-chung joined the faculty at CUHK. His current research interests include the physics of extra dimensions, cosmic microwave background radiation, neutrino oscillations, quark stars, and neutrino stars. Additionally, he serves as one of the coordinators of the Caltech-Hong Kong Undergraduate Research Fellowship (HKURF) Summer program. This summer two Caltech students went to Hong Kong—one to conduct research at the University of

Hong Kong and the other at CUHK. On the other side of the exchange, Ho Yeung Hung, a junior at CUHK, came to Caltech to work with Dr. Yuk Yung, and Man Ho Wong from Hong Kong Polytechnic University spent the summer working with Dr. Angelike Stathopoulos in biology.

We recently caught up with Dr. Chu via email.

Q Your SURF project was entitled “Maximum Likelihood Method in Track Reconstructions for the IMB Proton Decay Experiment.” What do you remember most about the research?

A I remember how much the project occupied my attention, even when I was not working in the lab or office. I still remember going to a Hollywood Bowl concert one evening that summer, and as I walked down the aisle, I couldn't help but think how much it was like the path of minimization in my program.

Q You are one of the rare Caltech undergraduates who continued on here to get a PhD. How much of what you studied in graduate school was influenced by your SURF experience?

A After SURF I was sure I wanted to continue on in physics research. I knew that's what I would enjoy the most. The decision to do a PhD at Caltech was just very natural to me.

Q What house did you live in?

A I was a transfer student, and so I never got to live in any of the undergraduate houses. I lived in Braun house for four years as a graduate student.

Q I noticed on your resume that one of your hobbies is “sleeping.” Is that something you gained interest in while at Caltech, or after?

A Oh I'd better not answer this one! I did acquire another of my hobbies while at Caltech. I used to do a lot of random walking at Caltech. The campus is so nice and it was so comfortable to walk around in the evening.

Q You are now a faculty member at The Chinese University of Hong Kong. Do you mentor undergraduates? What lessons did you learn from your SURF mentor that impacts the way you mentor?

A I mentor quite a few undergraduates now. This summer nine undergraduates carried out research projects in my group. I was puzzled by how often my mentors at Caltech offered words of praise, even for rather small and mundane tasks which did not ask for much intelligence on my part. Later I realized how important it was for a beginning researcher to get encouragement and spiritual support, because research is never a straight road.

Q Several years ago you worked with other alumni to launch a Caltech-Hong Kong SURF exchange program. Can you tell me how that got started? Why do you think this program is so important?

A It all started when a Caltech student, Sindy Tang, who is also from Hong Kong, contacted me about her idea to start something like the Caltech-Singapore SURF program. I had been sending some of my own students from The Chinese University of Hong Kong to Caltech for summer research, and I already knew how important such experience was to the students. So Sindy's idea sounded great to me and we quickly gained the support of the local chapter of the Caltech Alumni Association. Hong Kong is known to be a city of finance and commerce. Many of our brightest students go into finance and business, and those who like to take up a research career in science and technology are a discouraged minority. The Caltech-Hong Kong SURF program provides an invaluable opportunity for the brightest students in Hong Kong to experience what it's like to work with the best minds in the world. This I believe is the best way we Caltech alumni in Hong Kong—many of us former SURFers too—say thanks to Caltech and Hong Kong.

Q Do you have a favorite Caltech or SURF story?

A I always tell my students about how some Caltech students changed the HOLLYWOOD sign to CALTECH. So much team work and planning was involved, and it was so much fun. Above all, the daring spirit is invaluable.

HIGHLIGHTS OF **SUMMER 2010**

Allied Programs

SURF is one of several summer undergraduate research programs affiliated with the Student-Faculty Programs Office. Over 300 students conducted re-search as part of one of the following allied programs:

- MURF**
- Laser Interferometer Gravitational-Wave Observatory (LIGO) SURF**
- Caltech Amgen Scholars Program**
- NASA Undergraduate Student Research Program**
- NASA Space Grant**
- NASA Planetary Geology and Geophysics Undergraduate Research Program**
- Caltech-IIT Kanpur Exchange**
- Caltech-National University of Singapore Exchange**
- Caltech-Hong Kong Universities Exchange**
- Caltech-Cambridge Exchange**
- Caltech-University of Iceland Exchange**
- Howard Hughes Medical Institute EXROP**

SURFers 2010

<i>Class Level</i>	<i>Percent</i>
Freshman	26%
Sophomore	32%
Junior	40%
Senior	2%
Women	43%
Minorities	9%
Average GPA*	3.53

* Caltech students only, excluding freshmen

SURF Summer Program

Wednesday Seminar Series

Providing students an opportunity to learn about research across campus

Theodor Agapie

Assistant Professor of Chemistry
From Proteins to Small Multimetallic Complexes: Catalysis in the Context of Energy Conversion

John Johnson (SURF '99)

Assistant Professor of Astronomy
The Golden Age of Exoplanet Spin-Orbit Measurements

Jonathan Katz

Professor of Social Sciences and Statistics: Chair, Division of Humanities and Social Sciences
The Science of Politics: Estimating the Impact of Voter Identification Laws on Turnout

Sarah Reisman

Assistant Professor of Chemistry
Natural Product Total Synthesis: How Nature Helps Us Discover New Chemical Reactions

Linda Spilker

Cassini Project Scientist, Jet Propulsion Laboratory
Exploring the Saturn System: Cassini Science Highlights

Alexei Aravin

Assistant Professor of Biology
Small RNAs as Determinants of Epigenetic States in Germ Cells

Robert Clayton

Professor of Geophysics; Divisional Academic Officer for Geological and Planetary Sciences
Looking at the Earth With Seismic Networks

Jet Propulsion Lab Seminar Series

Providing students an opportunity to learn about the variety of research at JPL

John Callas

Project Manager, Mars Exploration Rovers
The Second Copernican Revolution: Our Changing View of Our Place in the Universe

Trina Ray

Group Supervisor, Science Planning Systems
Cassini-Huygens Mission to Saturn

Kobie Boykins

Group Supervisor, Mechanisms and Mobility
Development of the MSL Actuators

Steve Chien

Senior Research Scientist, Artificial Intelligence
Autonomous Spacecraft: Exploring Earth, the Planets, and Beyond...

Tomas Soderstrom

Manager, IT Chief Technology Office
IT Trends That Matter

Farisa Morales (SURF '00)

Staff Scientist, Spitzer Space Telescope Project
Debris Disks Around Main Sequence Stars via Spitzer IR Observations, Multiple-Belt Components, and Their Implications for Exoplanet Searches

Claudia Alexander

Project Scientist, US Rosetta Project
Astrobiology, or Who's Out There?

Cecilia N. Guiar

Formulation Projects Systems Engineer, Systems & Software
System Engineering at JPL

The William Whitney Workshops on Professional Development

Helping students make short-term career decisions in the context of long-term life and career goals

Career Planning

April White-Castañeda, *Senior Director of Employee and Organizational Development*

Understanding Your Leadership and Work Style

April White-Castañeda, *Senior Director of Employee and Organizational Development*
Lori Valdivia, *Employee Relations Consultant, Employee and Organizational Development*

Networking: How to Make It Work for You

Denise Nelson-Nash, *Assistant Vice President for Campus and Community Relations*
Dr. Helen McBride, *Senior Scientist, Amgen*
Dr. Jim Cutts, *Manager, Strategic Missions and Advanced Concepts Office, Jet Propulsion Laboratory*

Graduate School: The Nuts and Bolts of the Application Process

Dr. Joe Shepherd, *C. L. "Kelly" Johnson Professor of Aeronautics and Professor of Mechanical Engineering; Dean of Graduate Studies*
Dr. Felicia Hunt, *Associate Dean of Graduate Studies*
Lauren Stolper, *Director, Fellowships Advising and Study Abroad, and the Career Development Center*
Young In Oh, *Graduate Student, Chemistry*
John Meier (MURF '05), *Graduate Student, Mechanical Engineering*
John Zuckerman, *Graduate Student, Biochemistry, MD/PhD program*

Statistics From the 2010 Graduating Class

Total number of BS graduates	209	
Of these, the number graduating with Honors	116	56%
Total number of BS graduates who have done a SURF	164	
Of these, the number graduating with Honors	104	63%
Percentage of BS graduates who have done a SURF		78%
Number of prizes awarded to BS graduates	180	
Of these, the number of prizes awarded to SURFers	167	93%

SURFSAC Events

Each summer an energetic group of students works hard to plan social and cultural activities for the entire summer undergraduate population. The 2010 SURF Student Advisory Council (SURFSAC) provided an outstanding array of events, ranging from weekly “treats” on the Olive Walk, to a Santa Monica beach trip, to broomball at the Pasadena Ice Skating Center. Additionally, each week 15-20 students had the opportunity to share dinner with Caltech faculty at a local restaurant. We would like to extend a special thanks to Caltech’s Master of Student Houses, Professor Geoff Blake, for supporting these dinners. And, we’d like to thank the faculty who attended:

ODED AHARONSON, Associate Professor of Planetary Science

DAVID BALTIMORE, President Emeritus; Robert Andrews Millikan Professor of Biology; Nobel Laureate

KAUSHIK BHATTACHARYA, Howell N. Tyson, Sr., Professor of Mechanics and Professor of Materials Science; Executive Officer for Mechanical Engineering

GEOFFREY BLAKE, Professor of Cosmochemistry and Planetary Sciences and Professor of Chemistry; Master of Student Houses

MIKE BROWN, Richard and Barbara Rosenberg Professor of Planetary Astronomy

WARREN BROWN, Associate Professor of History

JOEL BURDICK, Professor of Mechanical Engineering and Bioengineering

JEAN-LOU CHAMEAU, Caltech President; Professor of Civil Engineering, Environmental Science and Engineering, and Mechanical Engineering

BIL CLEMONS, Assistant Professor of Biochemistry

JOHN DABIRI (SURF/MURF '00), Associate Professor of Aeronautics and Bioengineering

GEORGE DJORGOVSKI, Professor of Astronomy

STEVEN FRAUTSCHI, Professor of Theoretical Physics, Emeritus

KEVIN GILMARTIN, Professor of English
JULIA GREER, Assistant Professor of Materials Science

ROBERT GRUBBS, Victor and Elizabeth Atkins Professor of Chemistry; Nobel Laureate

MELANY HUNT, Professor of Mechanical Engineering; Vice Provost

ANDREW INGERSOLL, Earle C. Anthony Professor of Planetary Science

ROD KIEWIET, Professor of Political Science

DOUG MacMYNOWSKI, Senior Research Associate in Control and Dynamical Systems

BEVERLEY McKEON, Assistant Professor of Aeronautics

DAN MEIRON, Fletcher Jones Professor of Applied and Computational Mathematics; Associate Director, Graduate Aerospace Laboratories

MICHAEL PAUKEN, Lecturer in Mechanical Engineering

KEN PICKAR, Visiting Professor of Mechanical Engineering

ANNEILA SARGENT, Benjamin M. Rosen Professor of Astronomy; Vice President for Student Affairs

ALAN WEINSTEIN, Professor of Physics

ADAM WIERMAN, Assistant Professor of Computer Science

CoMAC

Co-mentors—the graduate students, postdoctoral scholars, and staff scientists who help mentor summer students—play a critical role in the success of SURF. The Co-Mentor Advisory Committee (CoMAC) has continued to help think about ways to best support co-mentors throughout the summer. This year, CoMAC selected its first Chair, Frank Truong, Graduate Student in Chemical Engineering. Frank designed and implemented a training workshop for first time and returning co-mentors. Additionally, Frank, along with other CoMAC members, helped organize two student/co-mentor and two co-mentor

peer-to-peer coffee hours. These coffee hours provided students and their co-mentors the opportunity to meet outside of lab and discuss research progress and academic goals.

Strengthening Effective Communication Skills

Throughout the year, SURF students are encouraged and provided opportunities to develop effective communication skills. This process begins with the research proposal which is submitted as part of the application and continues long after students give their final talk at Seminar Day. Here are just some of the ways in which students’ oral and written communication skills are supported.

Prizes—The Doris S. Perpall Speaking Competition was endowed by Robert C. Perpall (BS '52, MS '56) in memory of his late wife, Doris Perpall. The prize encourages students to prepare excellent SURF presentations. The competition is a three-round event. The best SURF Seminar Day presenters, as evaluated by the session chair and a judge from the discipline, advance to a semifinal round held in November. Six to eight finalists advance to a final round held in January. The 2009 winners were Yousif Kelaita, Brandon Hensley, and Carolyn Valdez/Thomas Gwinn (tied for third place).

The Gee Family Poster Competition was created by Barbara and John Gee to encourage and support excellence in scientific communication. Students delivering a research poster are encouraged to learn how to present highly technical informa-

tion to a general, yet educated, audience. Posters are judged on content, visual organization, and verbal presentation. The 2009 winners were Noele Norris and Marissa Weichman.

CURJ—The Caltech Undergraduate Research Journal (CURJ) is an award-winning undergraduate research journal, dedicated to highlighting the accomplishments of the numerous undergraduates conducting research during the SURF program and throughout the academic year. CURJ is edited, designed, and published entirely by students. The Spring 2010 issue featured articles by students Carolyn Valdez (SURF '07, '09; Amgen Scholar '08), Gabriel Mendoza (SURF '07, '08, '09, '10), Arthur Chang (SURF '07, '08), and Justine Chia (SURF '08, '09, '10). To view this issue, please visit: <http://curj.caltech.edu/>

CURJ has repeatedly won the National Pacemaker Award, administered by the Associated Collegiate Press and widely considered to be the Pulitzer Prize of student journalism. Entries are judged on content, quality of writing and editing, art and graphics, layout and design, and theme. CURJ won the prize in 2008, 2007, and 2004, and was a finalist this past year.

Abstract Book—SURFers are required to submit an abstract of their work, which is published in the SFP Abstract Book for Seminar Day. Abstracts are a succinct outline of the student’s research project. Students are instructed to use clear, significant words when writing the abstract, eliminating extraneous words, abbreviations, and jargon. Writing an abstract is a learned skill, and when all the abstracts are collected and compiled together, they

tell a wonderful story about the great work our students are doing! To view the SFP Abstract Book, visit: <http://tinyurl.com/23352vf>

Conferences—This year eleven students represented SURF at the Southern California Conference on Undergraduate Research (SCCUR). SCCUR 2009 was held at the California State University, Dominguez Hills, on November 22. It brought over 800 students from regional colleges and universities to present their research in oral and poster sessions. SCCUR is multidisciplinary including the sciences, the humanities, social sciences, art, and performance. SCCUR was started at Caltech in 1993.

SURFers 2010

Division	Total # of Students	CIT Students	Non-CIT Students	Mentors
Biology	52	43	9	24
Chemistry and Chemical Engineering	73	61	12	30
Engineering and Applied Science	118	90	28	43
Geological and Planetary Sciences	24	18	6	16
Humanities and Social Sciences	28	22	6	16
Physics, Mathematics, and Astronomy	97	64	33	60
Jet Propulsion Laboratory	45	23	22	29
Off Campus	32	29	3	30
International	11	11	0	11
Total	480*	361	119	259

*this includes LIGO and exchange SURF students

SURF, AND FRIENDS, IN THE NEWS

Congratulations to Professor John O. Dabiri (SURF/MURF '00), who was named a MacArthur Fellow. Each year the John D. and Catherine T. MacArthur Foundation awards "genius" grants to individuals who show "exceptional creativity in their work and the prospect for still more in the future."
http://media.caltech.edu/press_releases/13384

Welcome (back) John Johnson, Assistant Professor of Astronomy! In 1999, as an undergraduate at the University of Missouri, Rolla, Dr. Johnson SURF'ed with Ken Libbrecht (SURF '79). This summer he mentored three of his own SURF students. For more on Dr. Johnson visit:
<http://weblab.caltech.edu/features/57>

This summer the Undergraduate Admissions Office asked several SURFers to blog about their experience. Check out
> SURFing 101, by Megan Lo, Class of 2013
> SURFing: In the Genes, Mario Zubia, Class of 2013

Find these blogs, and others, at: http://caltech.typepad.com/caltech_as_it_happens/

Two of our Caltech Amgen Scholars—Caltech student Pradeep Ramesh and UC Berkeley student Michelle Vaisman—were featured on a KCLU story on the Amgen Scholars Program. Pradeep works with Rob Phillips and Michelle works with Jack Roberts.
http://www.kclu.org/news/local/story.php?story_id=746



Michelle Vaisman of Bryn Mawr College (and transferring to UC Berkeley) with her mentor, Dr. John D. Roberts. Not wanting to divulge a lady's age, we can say that Dr. Roberts has 77 more years of life experience than Michelle! Photo by Karen Vaisman (www.karenvaismanphotography.com)





FUNDING SURF

Each SURF student receives an award of \$6000 for the ten-week summer period, a total budget of over \$2 million. Funding is raised annually from a variety of sources including gifts from individuals, foundations, and corporations. Typically mentors pay half the award, and funds raised are used as matching funds.

SURF depends upon the generosity of its many friends for annual gifts or for contributions to the SURF endowment. A robust financial base ensures that Caltech students continue to have the opportunities to engage in research with faculty.

We thank the many donors who have supported SURF 2010 and beyond!

Endowments

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. Several years ago a very supportive alumnus and his wife offered \$2 million as a matching challenge to other SURF donors. They will match up to \$50,000 for those who contribute endowment gifts or pledges of \$75,000! Matches are still available!

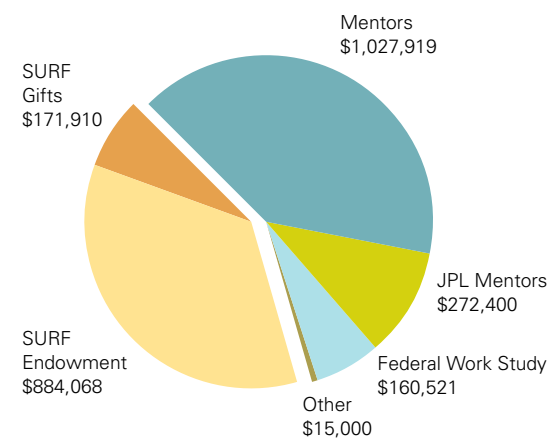
We are delighted to announce the establishment of two new endowments in 2010:

The Jean D. Dixon SURF Endowment was established by the Dixon Family in honor of their mother, Jean. The first Jean J. Dixon SURF Fellow is Paul Fleiner, a junior in physics. Paul worked with Professor Brad Filippone on a project entitled: "Development of a Cryogenic Magnet System for the nEDM Experiment."

The Dr. George R. Rossman SURF Endowment was established by Daniel and Sally Harris in honor of Dr. Rossman, the Eleanor and John R. McMillan Professor of Mineralogy at Caltech. The inaugural Rossman SURF Fellow is Matthew Diamond, a freshman in geology. Matthew conducted his research with Dr. Joe Kirschvink and studied the magnetic susceptibility of canning basin reef cores to better understand the Late-Devonian mass extinction. This is the third endowment established by the Harris!

2010 SURF Award Funding

\$2,531,818



Established Endowments

Thanks to the generosity of many committed donors, gifts to the SURF endowment will ensure students the opportunity to conduct research for generations to come. Scholar endowments provide support for five students annually in perpetuity. Fellow endowments provide support for one student annually in perpetuity.

SURF Scholar Endowments

Larson Scholars
Kiyo and Eiko Tomiyasu Scholars

SURF Fellow Endowments

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Robert T. Herzog SURF Endowment
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Edward W. Hughes SURF Endowment (1992)

Edward W. Hughes SURF Endowment (2005)
Richard T. Jones SURF Endowment
David S. Koons SURF Endowment
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Harold and Mary F. Zirin SURF Endowment

SURF Prize Endowments

Marcella and Joel Bonsall SURF Prize for Technical Writing
Gee Family Poster Competition Award
Doris S. Perpall SURF Speaking Award

Endowments Through Planned Gifts

Dr. and Mrs. George Boone
Dr. Paraskeva N. Danailov Endowed SURF Fellowship in Biology

Honor Roll of 2010 SURF Donors

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Dr. Barbara K. Rosenberg
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'07, '08
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