

CALIFORNIA INSTITUTE
OF TECHNOLOGY

1993



ANNUAL REPORT



IN MEMORIAM

Edward C. Posner
1933-1993

We were deeply saddened this summer by the sudden, tragic death of our friend and colleague, Ed Posner. Ed's commitment to the education of students was legend at Caltech and JPL. Through the SURF program alone he made a direct impact on almost 60 students. As one of our most active SURF research sponsors, Ed served as mentor to 13 SURF students since 1984 and three students were prepared to work with him this summer. In addition, Ed cofounded the SURFSAT satellite program with a JPL colleague in 1986. SURFSAT involves successive teams of undergraduate students who are designing, building, and testing a small communications satellite to support the research objectives of NASA's Deep Space Network. Since its inception, 43 students have participated in SURFSAT. Ed's legacy to the education of young people stretches far and touches many as evidenced by his involvement with SURF, one program on his long list of interests. We shall all miss Ed very much.



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DEDICATION

This year's SURF program is dedicated to Robert F. Bacher, professor of physics, emeritus, in recognition of his outstanding contribution and commitment to Caltech. He has been called "one of Caltech's greatest assets" and, together with Lee DuBridge, President Emeritus of the Institute, helped forge the Caltech into what it is today. We are proud to honor him.



PRESIDENT'S MESSAGE

My heartiest congratulations to SURF on its fifteenth anniversary! The vision of SURF's founder, Fred Shair, to provide an environment in which students can work as colleagues with their mentors to ask new questions and seek solutions to unsolved problems, and to gain insight into career preferences, remains the guiding principle. The celebration this summer has been dynamic with 232 students carrying out independent research with their mentors. It has been rich with a variety of stimulating discussions and seminars.

I want to thank the SURF team, over 450 people who, through their generous contributions of time, money, talent, and leadership, make SURF the unique program it is. The Institute is proud of SURF, and we look forward to its continued success.

Thomas E. Everhart
President

Caltech's Summer Undergraduate Research Fellowships program introduces undergraduate students to research under the guidance of seasoned research sponsors. Students experience the process of research as a creative intellectual activity and gain a more realistic view of the opportunities and demands of a professional research career.

HOW SURF CARRIES OUT ITS MISSION

Through SURF, which is modeled on the grant-seeking process, students enter the environment of scientists. In collaboration with their research sponsors, students write project proposals which are reviewed by a faculty committee. Awards are made on the basis of recommendations of the reviewers and available funding. Work is carried out during ten weeks in the summer; at the conclusion of the summer, students submit a technical report and give an oral presentation on SURF Seminar Day, a symposium patterned after a professional technical meeting. As with any grant award, students receive a stipend; in 1993 the stipend was \$3,600.

The SURF program offers a wealth of enrichment activities to enable students to broaden their knowledge of a variety of fields, to consider many aspects of a research career, and to balance their research experiences with cultural and social activities. The Director's Report describes these activities.

THE SURF ADVANTAGE

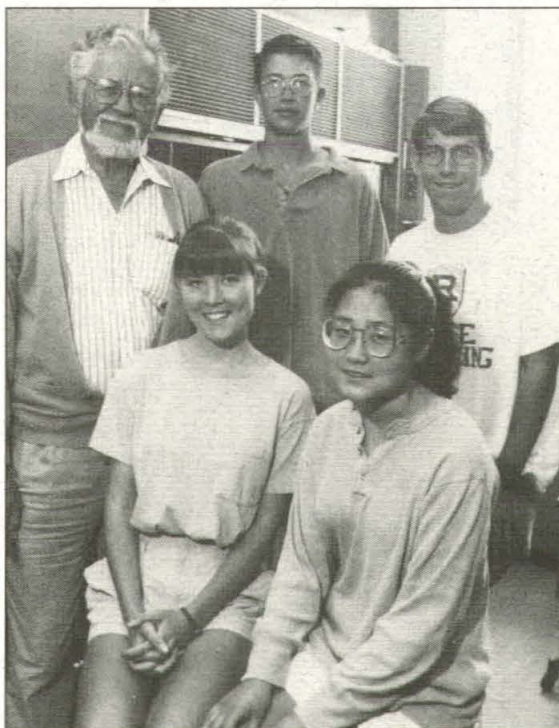
The mentor-protégé association is the most important aspect of the SURF experience. This alliance encompasses not only the student's summer project but also professional relationships within the research group and the broader research community, the economics and politics of research, and ethics.

Students discover how exciting front-line research can be. They also struggle with the frustrations. They gain insight into what a researcher's professional life is like. Many students solidify their desire to pursue research careers; some revise their career plans.

SURF provides a new dimension to the process of undergraduate education. Graduates of SURF, with their sophisticated and practical knowledge of how to conduct research, have a marked advantage as they embark on their career paths, apply to graduate schools, or look for jobs in industry.

The Institute benefits from the SURF program. Many entering freshmen report that they chose Caltech because of the chance to do undergraduate research. Some departments have recruited graduate students through the SURF program. The program helps to strengthen the links between students and faculty; between Caltech and JPL; between the Institute and alumni, donors, the community, and other colleges and universities.

The heritage of SURF is rich. SURF's benefits reach far and touch many. The program positively affects students as they prepare for their careers, it benefits the Institute, and it builds bridges among individuals, organizations, and institutions.



Jack Roberts with SURFers Matt Goff, Karl Haushalter, Diana Fort, and Susan Shin



REPORT OF THE SURF BOARD

Lew Allen

As SURF concludes its fifteenth year, we pause to reflect on the growth and development of this remarkable program. From the first 18 participants in 1979 to the 232 students

who worked with mentors this summer, a total of 1306 individuals have been enriched by the opportunities offered by SURF. SURF's success is due to the dedication of a number people committed to the educational values espoused by SURF, and we on the SURF Board take great pride in our association with this program.

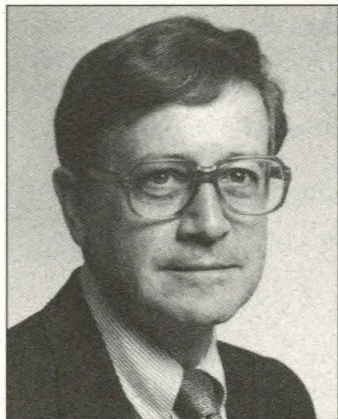
Formed in 1982, the SURF Board is a voluntary support organization consisting of individuals dedicated to the educational values of undergraduate research at Caltech, and who, through their advice, encouragement, and financial support, contribute to the vitality, continuity, and effectiveness of the SURF program.

This year the SURF Board has continued to pursue its objectives to help bring SURF into a more robust financial position, and we have made important progress.

- The Administration, through President Thomas Everhart and Provost Paul Jennings, agreed to underwrite up to 20 stipends for Caltech students recommended by the Administrative Committee to receive awards. This agreement alleviates the uncertainty caused by the late receipt of stipend moneys. Any shortfall in fund-raising will be compensated by reducing the size of the following SURF class.
- The Administration assured us that SURF is listed with other fellowships and scholarships on the Institute's fundraising priority list.
- The Fund-raising Committee, consisting of the entire Board (under the leadership of Hannah Bradley), met with Joanne Clarey, Kevin Doody, and Donna Brown of Development's Corporate Relations staff, to review lists of Caltech alumni at the vice president level and higher in local companies. The purpose is to begin to introduce these companies to the SURF program.

- At its June meeting, Joanne Clarey announced to the Board that she has received authorization to create a Small Business Associates program. For an annual membership fee, the program will offer such Caltech resources as library privileges, consultation with faculty, attendance at the Research Directors Conference, seminars, and SURF sponsorship. The Corporate Relations Office will make initial contacts and, as appropriate, turn leads over to the SURF Board.
- SURF Board member Robert C. Perpall has generously created the Doris S. Perpall SURF Speaking Awards as an incentive for students to prepare excellent final oral presentations on SURF Seminar Day in October. The first-place winner will receive \$500; second, \$300; and third, \$200. Two Honorable Mentions will also be named. We thank Bob for his commitment to the communications program.
- The Board and the SURF Administrative Committee held a joint meeting last fall to report on their missions, goals, and activities. The meeting will become an annual activity to promote communication and unity between these constituencies.
- The SURF Board committees remained active this year. The Campus Liaison Committee, under the chairmanship of Bill Whitney, coordinated a successful series, *Can You Do Research for a Living?* The committee also identified all Roundtable speakers for this year's SURF program, and committee members facilitated each session. The Student Relations Committee, chaired by Joanna Muir, held the annual "thank-you note-writing" party to encourage named SURF students to personally thank their financial sponsors. The committee also hosted special activities for students attending the National Conference on Undergraduate Research at the University of Utah in March.

I look forward to 1994 with optimism. The Board will continue to meet the challenges of fund-raising and enriching the program. SURF is a unique and important educational activity, and it deserves the support of the Board and its many friends.



REPORT OF THE SURF ADMINISTRATIVE COMMITTEE

Terry Cole

The SURF Administrative Committee consists of faculty from each of Caltech's six academic divisions; members of the JPL

senior technical staff; three student members including the president of ASCIT, representing the student researchers; and members of Caltech's administrative staff. The role of the SURF Administrative Committee is to establish academic policy and maintain the pedagogical excellence of SURF. The committee also advises the Administration on the long-term planning and development of SURF and related programs which may evolve in the future.

An important responsibility of the SURF Administrative Committee is to review the students' proposals which numbered more than 300 this year. Overall the proposals were outstanding, reflecting the collaboration between the research sponsors and students. Competition for available funds was strong.

We note that the new financial plan adopted by the Caltech administration has been a major help in

facilitating the acceptance of student applicants to the program. Under this arrangement Caltech underwrites the student stipend funds against money expected from fundraising but not yet received.

The goal of SURF is to provide opportunities for Caltech and selected undergraduates from other universities to carry out independent research under the direction of leading scientists and engineers. Our objective is to assure funding for every Caltech student who meets the criteria of the faculty and JPL sponsors. A testament to the research excellence of SURF is the statistic that over 20% of SURF students coauthor papers in the professional technical literature.

We extend deep sympathy to the family of Ed Posner. He was a member of the Administrative Committee since 1991. We will miss Ed's sense of humor, his dedication to SURF, his commitment to unique educational experiences for outstanding young people. We thank his family for directing memorial contributions to SURF.

We look ahead with enthusiasm to the continuing development of undergraduate research at Caltech.



DIRECTOR'S REPORT

Carolyn Merkel

We celebrated SURF's fifteenth anniversary summer with a record 232 students participating in this year's varied and expanded program. Students had the chance to

hear excellent seminars by Caltech faculty and JPL staff. Discussions, workshops, and tours enriched the research experience. SURF '93 was an international program with seven students from Europe and one from Russia.

SURF's long-term success can be attributed to the commitment of the research sponsors and outstanding students. We depend upon and value the the generous financial contributions of our many friends, the vigorous support of the SURF Board, the dedication of the SURF Administrative Committee, and the efforts of many volunteers.

Eleven students participated in the Minority Undergraduate Research Fellowships (MURF) program in the divisions of biology and chemistry and chemical engineering. These students apply individually to the MURF program, and are matched to a research group according to their research interests. Once they have been accepted to MURF, they participate fully as SURF students.

CONGRATULATIONS SURFERS!

At the 1993 commencement:

49% of the students receiving bachelor's degrees had done a SURF.

68% of the students graduating with honors were former SURFers.

77% of the students receiving prizes were SURF students.

PROFILE OF THE 1993 SURFERS

<i>Division</i>	<i>Number of Caltech Students</i>	<i>Number of Non-Caltech Students</i>	<i>Total Number of Students</i>	<i>Number of Research Sponsors</i>
<i>Biology</i>	26	14	40	25
<i>Chemistry and Chemical Engineering</i>	37	11	48	22
<i>Engineering and Applied Science</i>	35	3	38	29
<i>Geological and Planetary Sciences</i>	6	1	7	4
<i>Humanities and Social Sciences</i>	6	1	7	6
<i>Physics, Mathematics and Astronomy</i>	36	3	39	21
<i>Jet Propulsion Laboratory</i>	26	21	47	30
<i>Off-Campus</i>	6	0	6	6
	177	54	232	143
<i>Sophomores:</i>	21%	<i>Women Students:</i>	30%	
<i>Juniors</i>	32%	<i>Minority Students:</i>	13%	
<i>Seniors:</i>	47%			

SURF FUNDING

This year the Administration agreed to underwrite up to 20 SURF student stipends against funds expected, but not yet received, from fund-raising efforts. Any shortfall in fund-raising will be compensated by a reduction of the subsequent SURF class. This agreement facilitated the award process, eliminating the lengthy waiting list we have used in the past. We are pleased that 1993 fund-raising covered this year's commitment. We thank President Thomas Everhart and Provost Paul Jennings for establishing this agreement, and we appreciate the support of Vice Provost David Goodstein.

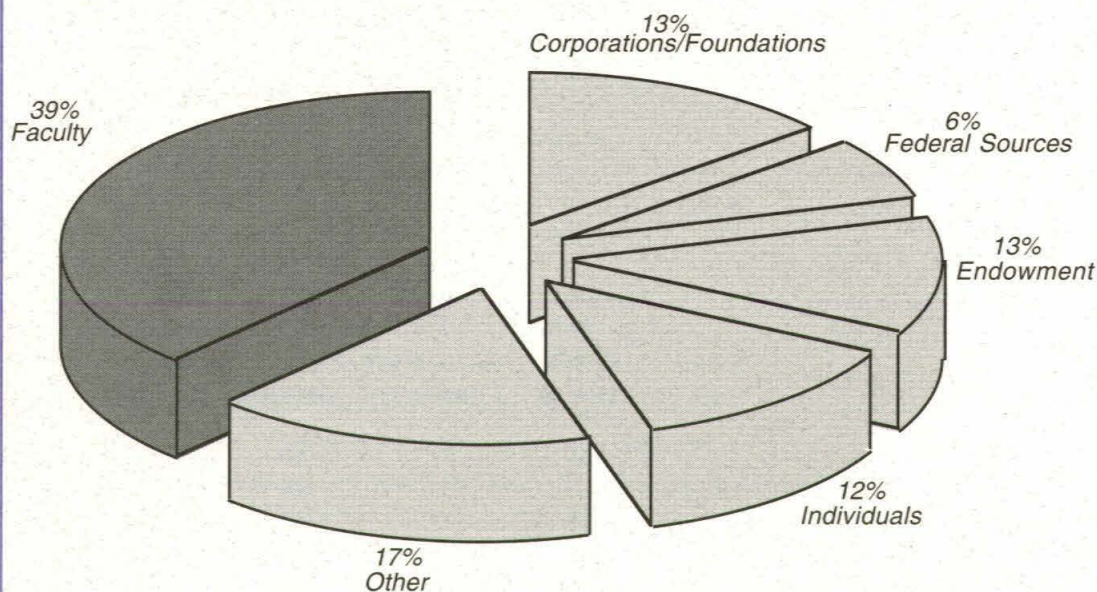
Each SURF student received a stipend of \$3600 for the ten-week period. Total stipend costs for this year's program were \$835,200. For students working with faculty on the campus, funds are raised from a variety of sources (shown on the graph below) to match stipend moneys provided from faculty research grants. Students working at JPL are fully supported from NASA funds.

Since the Institute pays the administrative costs of SURF, and research sponsors pay research costs, all funds raised from outside sources are used for student stipends or special research-related opportunities.

SURF ENDOWMENTS

An endowment has been created to ensure the continuation of SURF. Individuals may establish an endowment, named as the donor designates, for \$75,000; the proceeds from the fund will support one student annually in perpetuity. Twenty-one endowments have been created.

This chart shows sources of funds raised to match moneys provided faculty for SURF students working at Caltech



MEMORIAL FUNDS

We thank the family of Dr. Posner for creating the Edward C. Posner SURF Memorial Fund. This fund will support a student in a field related to Ed's professional interests. We are grateful to his family, friends, colleagues, and students for their generous contributions; it is a fitting memorial to his commitment to the education of outstanding young people.

We thank the contributors to the Chandler C. Ross Memorial Fund for their continued generosity in providing a stipend in honor of their colleague.

GROWTH OF THE SURF PROGRAM

Since SURF's founding in 1979 by Professor of Chemical Engineering Fred Shair, the number of students participating each summer has continued to grow and the opportunities for enrichment have expanded and diversified. Eighteen students worked that first summer with 17 faculty members. In 1983 the first student worked at JPL, and in 1985 the first non-Caltech student joined the program. We salute the 1,306 individuals (who have carried out a total of 1,614 projects) and their research sponsors, who have SURFed at Caltech over these 15 years!

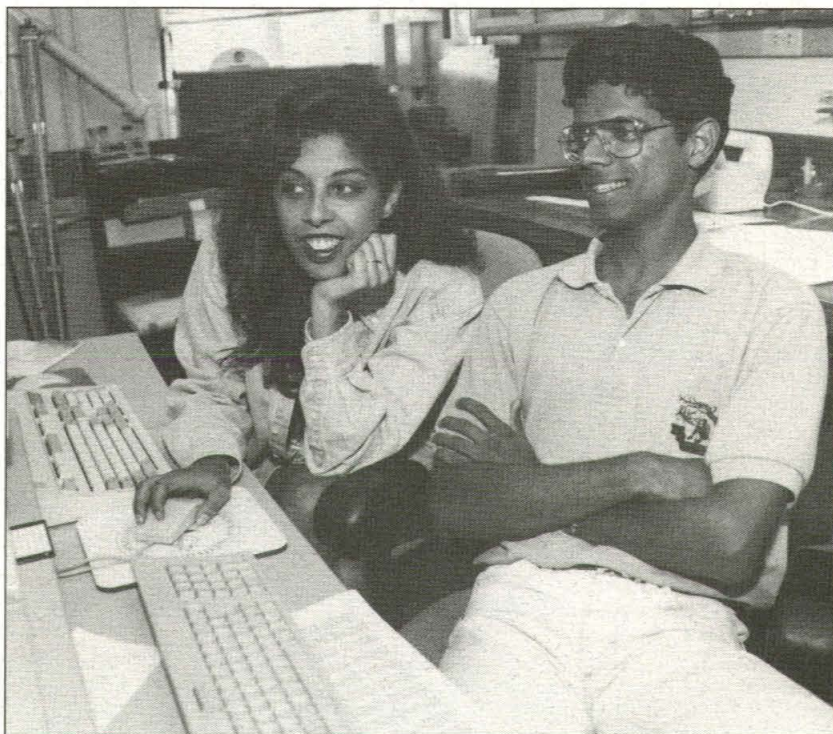
ENRICHMENT PROGRAMS

CAN YOU DO RESEARCH FOR A LIVING?

Caltech alumni Bill Whitney (Division Technologist, Observational Systems Division, JPL) and Julie Kornfield (Assistant Professor of

Chemical Engineering) coordinated *Can You Do Research for a Living*, a series of discussions Bill developed three years ago. Each of the informal sessions addressed issues students will face as they prepare for and commence their professional careers.

The initial session focussed on five basic decisions affecting research careers. In the second meeting, the discussion centered on developing credentials, research documentation, patents, and ethics. Topics for the third week were defining career expectations and decision-making styles. The final session provided information on getting into graduate school, writing a personal statement, fellowships, and tests. A former SURF student, now a graduate



Maha Zewail and Jose Garcia

student at Caltech, and his wife provided a retrospective on their experiences and thoughts leading to their decisions concerning graduate school.

Discussion leaders included Bill Whitney, Julie Kornfield, Fred Shair (Manager of Educational Affairs, JPL), Carole Snow (Director, Caltech Undergraduate Admissions), Paul Robinson (Assistant to the Chief Technologist, JPL), Sally Asmundson (Director, Career Development Center), Tab Stephens (Graduate Student), and Keri Stephens (Account Executive, Xymark Corporation).

In a panel discussion entitled "Scientists as Speakers," Harry Gray (Arnold O. Beckman Professor of Chemistry), Terry Cole (Chief

Technologist, JPL, and Chair, SURF Administrative Committee), and Mary Kennedy (Professor of Biology) talked about their experiences as speakers, described how they prepare for talks to both technical and general audiences and how they develop transitions and analogies. They shared advice with the students from their own experiences and observations of excellent speeches.

SEMINARS

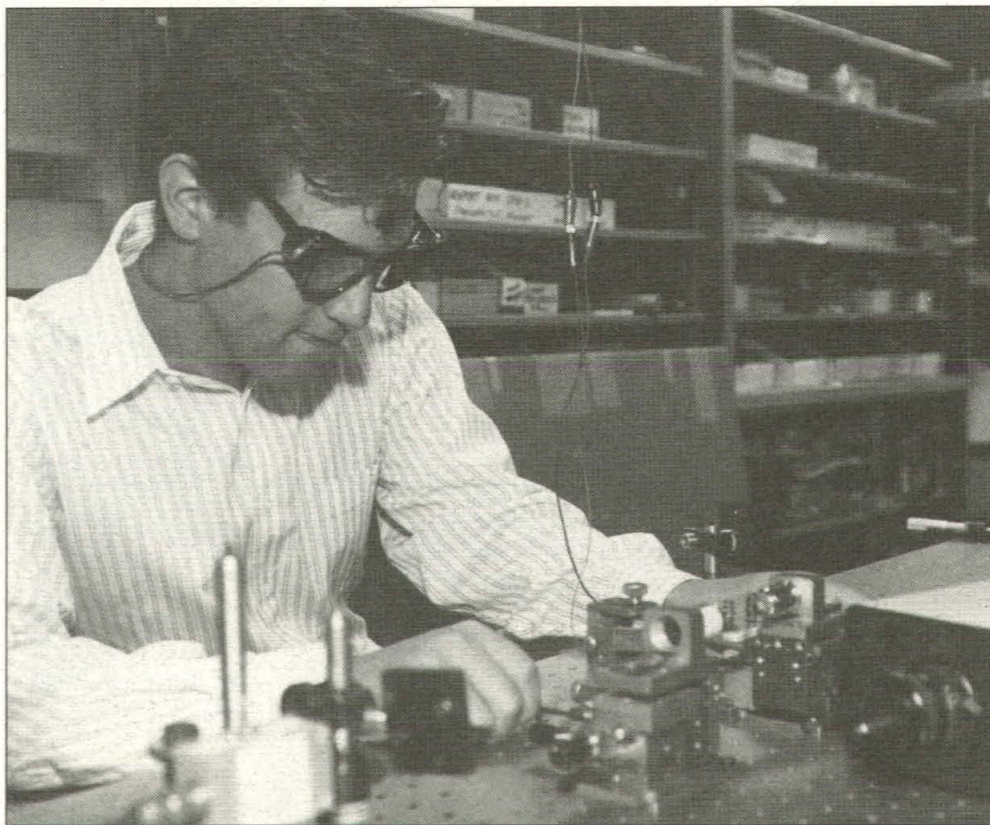
Caltech Seminar Series

Each Wednesday, members of the Caltech faculty or JPL technical staff presented overviews of their areas of research. Speakers and topics were:

Frances H. Arnold, Associate Professor Of Chemical Engineering, *New Biocatalysts from Old Enzymes: Enzyme "Evolution" for Odd Environments*

Andrew Lange, Associate Professor of Physics, University of California, Berkeley, *It's NOT All Relative*

Gilles J. Laurent, Assistant Professor of Biology and Computational and Neural Systems, *Information Processing By Neurons in the Brain*



Uri Cummings

Mary E. Lidstrom, Professor of Applied Microbiology, *Bioremediation of Toxic Wastes by Bacteria*

Rudolph A. Marcus, Arthur Amos Noyes Professor of Chemistry, 1992 Nobel Laureate in Chemistry, *Electron Transfer Reactions*

Richard D. McKelvey, Professor of Political Science, *Rationality and Altruism in Games*

Thomas J. Meade, Senior Research Fellow in Biology, *Chemists at the Interface: Magnetic Resonance Imaging at Cellular Resolution*

Ellen Rothenberg, Associate Professor of Biology, *Molecular Basis of Education in the Immune System*

Edward M. Stolper, William E. Leonhard Professor of Geology, *How Volcanoes Work*

Joe Waters, Senior Research Scientist, JPL, *The Chlorine Threat to Stratospheric Ozone*

JPL Seminar Series

Each Friday members of the JPL technical staff presented summaries of their work to the JPL SURF students. Speakers and their topics were:

John R. Brophy, Mechanical Systems Engineering and Research Division, *Electric Propulsion Technology*

James E. (Jake) Jacobson, Institutional Computing and Mission Operations Division, *Navigating JPL's Bandwidth Requirements Through the 90's*

Allan Johnston, Hardware Assurance Division, *Space Radiation Effects on Present and Future Microelectronics*

A. Lonnie Lane, Office of Space Science and Instruments, *JPL Oxidant Experiment (MOx) for the Russian Mars '94 Mission*

Meemong Lee, Observational Systems Division, *PLATO - Planetary Analysis Tools*



Lucy Chen

Roger Linfield, Telecommunications Science and Engineering Division, *Calibrating the Earth's Troposphere for Spacecraft Navigation Measurements*

Kristy L. Marski, Information Systems Division, *CD-ROM Production Process*

J. Kurth Reynolds, Electronics and Control Division, *Micromachined Tunnel Sensors*

Rex Ridenoure, Systems Division, *Microspacecraft Development Program*

Roundtable Discussions

Roundtable discussions provided small groups of students the opportunity to meet with leaders in

academia, industry, or government to discuss current topical or career development issues. Discussion leaders this summer were:

J. Douglas Andrews, Assistant Dean and Director, Evening MBA Program, USC, *Are Managing Skills Needed in a High-Technology Environment?*

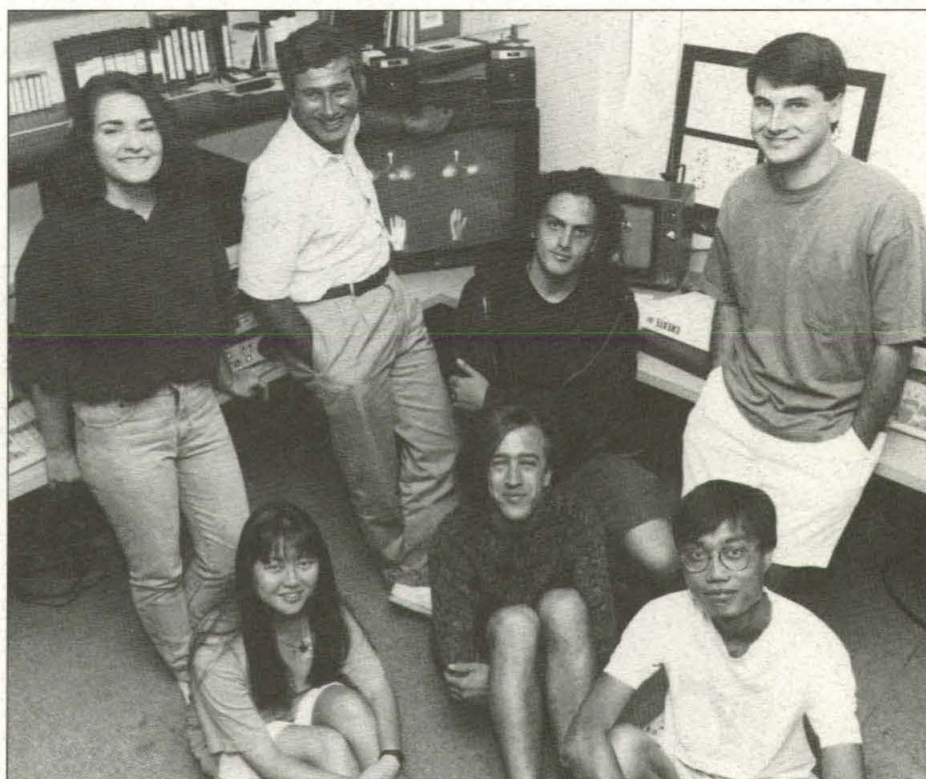
Lon E. Bell, President, Amerigon Inc., *Technology Investment Strategy*

Terry Cole, Chief Technologist, JPL, and **Julie Kornfield**, Assistant Professor of Chemical Engineering, *Career Research Opportunities: Academic, Industry, Governmental Laboratories*

Paula Grunthaner, Group Supervisor, Electronics and Control Division, JPL, and **Mary Bothwell**, Division Scientist, Observational Systems, JPL, *Balancing Career and Family: Two Approaches*

Ed Lambert, General Partner, Meridian Strategies, *Opportunities in Consulting and Business*

Gaylord E. (Nick) Nichols, Director, Industrial Relations Center, Caltech, *Entrepreneurship: Using Your Technical Background to Start Your Own Business*



Nate Lewis' Chemistry Animation Project team:

Teresa Stachura, Nate Lewis, Michael Medaglia, Chris Bryant, Elizabeth Lee, Scott Townsend and Andre Yew.

Thomas A. Tombrello, Professor of Physics, Caltech, and **Lucy Hair**, Chemical Sciences Division, Lawrence Livermore National Laboratory, *Comparison of the Research Environments in Academic, Industrial, and National Laboratories*

Elizabeth (Lisa) Wilson, Science Writer, Pasadena *Star-News* and **Jay Aller**, Science Writer, Caltech Public Relations Department, *Communicating Science to the Public*

TOUR OF MT. WILSON

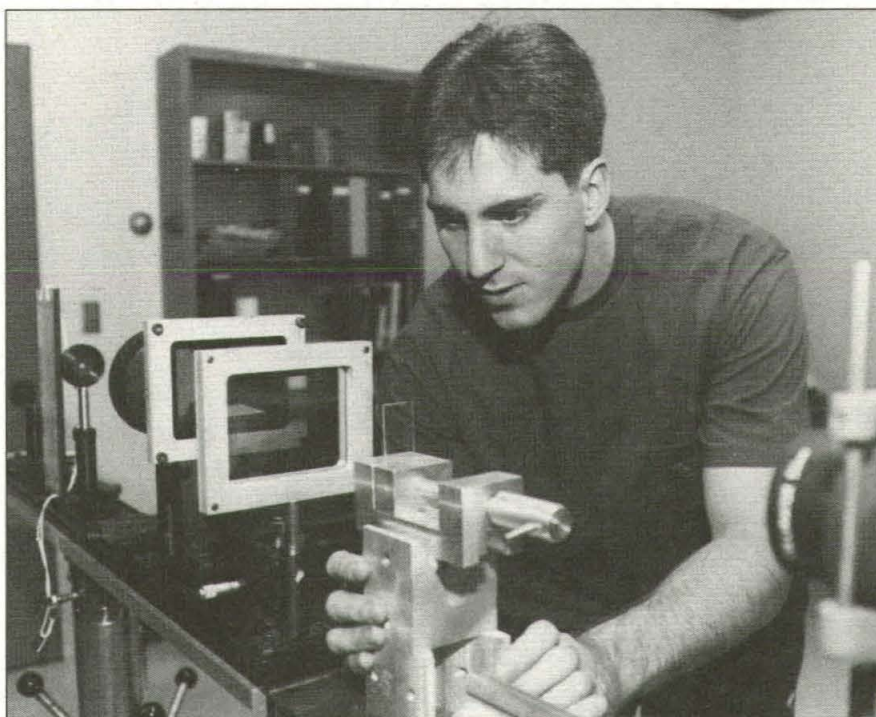
Gilbert Clark, Director of Telescopes in Education (TIE), Mt. Wilson Institute (MWI), and Staff Engineer, Technical Divisions Office, JPL, invited SURF students to the Mt. Wilson Observatories to meet Dr. Robert Jastrow, President, MWI, and to tour the recently refurbished 24-inch telescope and the 100-inch Hooker telescope. Dr. Jastrow reviewed the history of astronomy and the advances in astronomical technology being developed and installed on the equipment at Mt. Wilson. In a separate event, SURFers viewed the Perseid Meteor Shower from the mountain.

MYERS-BRIGGS TYPE INDICATOR

Kathy Harris, Supervisor, Professional Development, JPL, presented a three-session series on the Myers-Briggs Type Indicator. She administered the MBTI instrument, and described the theory of temperament preferences, the development of the research, and its implications in career choices and work styles.

COMMUNICATION PROGRAM

For many SURF students, the required oral presentation on Seminar Day was their first experience in public speaking. To help them prepare for this talk, SURF offered a communication program under the direction of Mary Ann Smith, communication consultant.



Quentin Travis

DORIS S. PERPALL SPEAKING AWARDS

Robert C. Perpall, a member of the SURF Board, generously created the Doris S. Perpall SURF Speaking Awards as an incentive for students to prepare excellent final oral presentations on SURF Seminar Day in October. The first-place winner will receive \$500; second, \$300; and third, \$200. Two Honorable Mentions will also be named.

THE SURF TALK BOOK

New this summer was *The SURF Talk Book*. The purpose of the book was to provide students with written materials, exercises, guidelines, and checklists to help them with final preparation for their oral and poster presentations.

WORKSHOPS

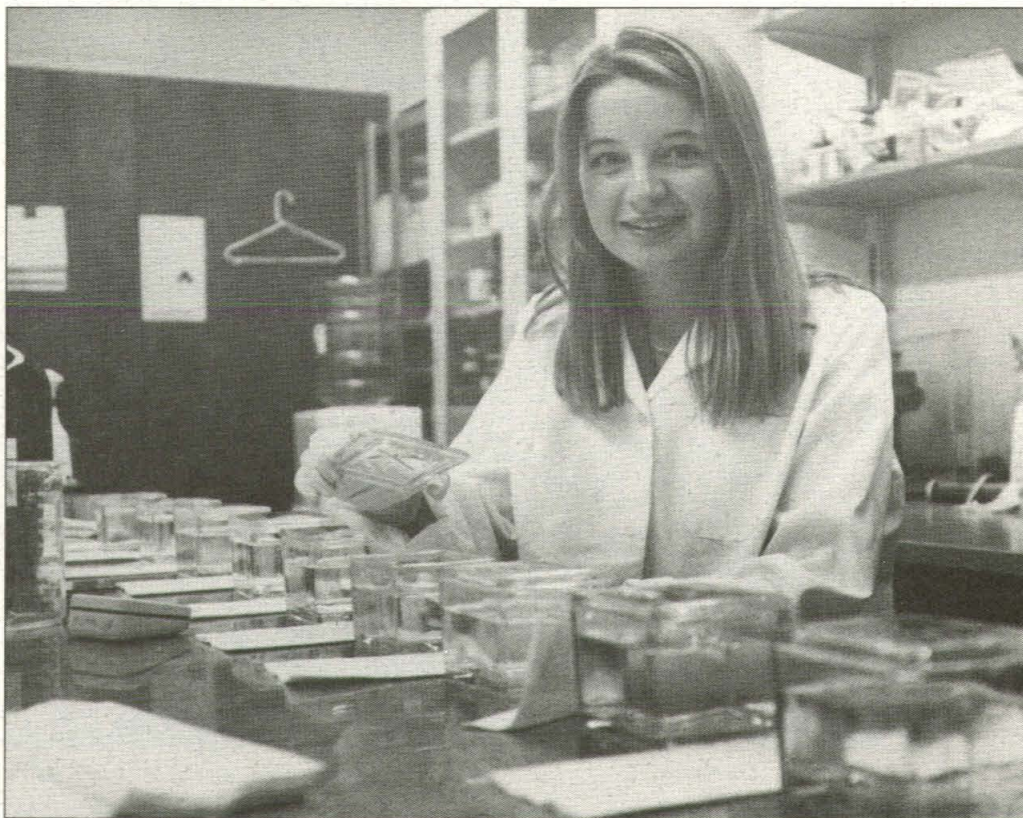
Many students participated in three small-group workshops led by trained peer facilitators. They gained experience and confidence as they talked about their research in the group; they learned public speaking techniques and skills; workshop assignments led them through speech organization, development of analogies to describe technical information, and creation of visual aids.

Since students within the small groups represented a variety of research areas, the diversity of interest and background in the group helped them recognize the necessity for clear explanations even with a technically educated audience. The workshops enhanced the pedagogical aspects of the

research; as they recognized the necessity of gaining a more thorough understanding of their research to be able to communicate it clearly, students learned to ask more interpretive questions of their research sponsors.

INTENSIVE REHEARSALS

In one-hour meetings with trained Peer Coaches, SURF students finalized organization of the talk, put finishing touches on visual aids, learned relaxation techniques, or rehearsed.



Gisela Sandoval

SCIENTISTS AS SPEAKERS

Ms. Smith moderated a panel of faculty recognized as excellent speakers—Terry Cole, Harry Gray, and Mary Kennedy. The panel underscored the importance of clearly communicating technical information to general as well as technical audiences. Students learned that as confident and comfortable as they appear, these scientists carefully prepare and rehearse their talks. The panel shared their views of what makes a speech excellent, and pitfalls to avoid.

PILOT PROGRAM WITH UNIVERSITY OF CALIFORNIA, SANTA BARBARA

This summer we developed a pilot program to exchange undergraduate student researchers with the University of California at Santa Barbara. Three students from each institution carried out independent research with faculty at the other university. Students were enthusiastic and appreciative of the chance to participate in a different research environment, and we plan to continue this program.

UNDERGRADUATE RESEARCH CONFERENCES

As part of its fifteenth anniversary celebration, SURF will host the first annual Southern California Conference on Undergraduate Research (SCCUR) at Caltech on November 6. SCCUR is open to

undergraduate researchers in all fields. The theme for the conference is "Jurassic Park." Keynote speakers will be Leroy E. Hood, William Gates III Professor of Biomedical Sciences, University of Washington, "*Jurassic Park: Fact or Fiction?*"; and Dean Cundey, Cinematographer and Director of Photography for the film *Jurassic Park*, "Future Applications of the Creative Technology Developed for *Jurassic Park*." SCCUR Roundtables at lunchtime will address issues and themes raised in the book and film.

Twelve 1992 SURF students represented Caltech at the Seventh National Conference on Undergraduate Research at the University of Utah in March. We thank the Caltech Chapter of Sigma Xi, donors, and faculty who paid travel costs for the students to attend the conference. The students report the experience was stimulating, interesting, and rich. Caltech hosted the fifth NCUR in 1991 as part of the Institute's centennial celebration.



Aron Rempel



SURF INDEX OF STUDENTS AND SPONSORS

STUDENT

Rasheeda A. Abdush-Shaheed

Senior, Ch
Lincoln University
MURF

Moeen Abedin

Senior, Bi
Caltech Alumni Association SURF

Sakena Abedin

Junior, BioCh
Harvard University

Gypsy R. Achong

Sophomore
Dr. and Mrs. David C. Elliot SURF

Ali Alagheband

Senior, ME
Mr. and Mrs. Ralph W. Jones SURF

Michelin A. Aldridge

Senior, Bi
Mr. and Mrs. Downie D. Muir III
SURF

Jose Alemar

Sophomore, MicroBi
University of Puerto Rico
MURF

Hussein Ali

Senior, ME
Ford Motor Company SURF

Erica L. Alliston

Senior, Bi
Howard Hughes Medical Institute

Jasmine R. Anderson

Junior, Ch
Peter A. Lindstrom SURF Endowment

Michael V. Anshelevich

Senior, Ma
Richter Scholar

Suzanne Astle

Senior, Ge
Utah State University

Daniel D. Bahmiller

Senior, Bi
Davidson College

Jonathan E. Baker

Senior, Pb
NASA

Won Bang

Senior, ME
Mr. Kaname Kitsuda SURF

TOPIC

Natural Production of Bromoform and Dibromomethane by Marine Macroalgae

Determination of Autophosphorylation Site(s) on the nimI Dual Specific Protein Kinase

The Preparation and Modification of Microperoxidase 8

Database of all Observations of Cepheid Variables for the Development of an Extragalactic Distance Scale

Performance Optimization of a Small Hexapod Robot (Stiquito)

Expression of Recombinant Protein

Making a Set of Hybrid Constructs Composed of Different Lengths of the P1 Promoter Region Fused to a Reporter Gene

Finite Element Analysis of Discontinuously Reinforced Titanium and Intermetallic Composites

Isolation of the Gene Encoding MCBF

Synthesis of a Cyanophthalide Intermediate for the Synthesis of Dynemicin-A, a Potent Natural Antitumor Agent

A Simple Model for DLA

High Temporal Resolution GPS Measurements of Far-Field Crustal Deformation During the June 28, 1992, Landers and Big Bear, California, Earthquake Sequence

Modeling the Acute Human Response to Exercise

Observations of the Cosmic Microwave Background

Segregation of Binary Mixture Particles Down an Inclined Glass Chute

RESEARCH SPONSOR

Mary E. Lidstrom
Professor of Applied Microbiology

William G. Dunphy
Assistant Professor of Biology

Ruth Margalit
Staff Scientist, JPL

Barry F. Madore
Research Astronomer, IPAC

Richard M. Murray
Assistant Professor of Mechanical Engineering

Stephen L. Mayo
Assistant Professor of Biology

Elliot M. Meyerowitz
Professor of Biology

Thomas A. Christman
Assistant Professor of Materials Science and Applied Physics

Judith L. Campbell
Professor of Chemistry and Biology

Andrew G. Myers
Associate Professor of Chemistry

Nikolai G. Makarov
Professor of Mathematics

David M. Tralli
Member of the Technical Staff, JPL

John C. Doyle
Professor of Electrical Engineering

Anthony C.S. Readhead
Professor of Astronomy

Melany L. Hunt
Assistant Professor of Mechanical Engineering

STUDENT

Jeffrey M. Barker
Senior, ME

Elizabeth J. Barton
Senior, Ph/Ma
NASA

Troy J. Bassett
Senior, Ma/Lit
Dr. and Mrs. Robert L. Noland
SURF

Serge J. Belongie
Junior, EE
Northern California Associates
SURF Endowment

Zackary D. Berger
Junior, Bi
Richter Scholar

Abhijit S. Bhalla
Junior, Ae
Tosbi Kubota Aeronautics
SURF Endowment

Seth Blumberg
Sophomore, Ph/AMa

Rene F. Borbon
Sophomore, ChE
Massachusetts Institute
of Technology
MURF

Ned B. Bowden
Senior, Ch
Sidney R. and Nancy M. Peterson
SURF Endowment

Charles K. Boyce
Junior, Bi/Lit
Class of '36 Endowment Fellowship

Gregory R. Bradley
Senior
Morehouse College
MURF

Walter F. Briskin
Sophomore, Ay/APh
NASA

C. Titus Brown
Sophomore, Ma/Ph
Reed College

Ross H.L. Brown
Sophomore, EAS

TOPIC

SURFSAT Structure Sub-System Engineering

Magnetic Fields in Clusters of Galaxies

An Imitation and Appreciation of James Joyce's *Dubliners*

Rotation Invariant Texture Recognition in a Multiresolution System

Isolation of the Bacterioferritin Gene of *Aquaspirillum magnetotacticum*

Investigation of the Bulk Constitutive Properties of ZrNiCuAl Metallic Glass Samples

Determining the Heat Capacity for Binary Fluids with Fixed Impurities

Measurements of Ultrafine Aerosol Formation in Atmospheric Photochemical Reactions

Ring Closing Metathesis

Research into the Magnetic Sensitivity of Animals: Humans and Honey Bees

Does Normal Cerebral Brain Specialization Develop in Agenesis of the Corpus Callosum?

Multicolor Detection of High-Redshift Quasars

Evolution in a Virtual Environment: A Self-Organizing Approach

Preliminary Mass Survey for the Science Instruments on the Pluto Fast Flyby Project

RESEARCH SPONSOR

James Holden
Member of the Technical Staff, JPL
Steven Johnson
Member of the Technical Staff, JPL

Anthony C.S. Readhead
Professor of Astronomy

Ronald L. Bush
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Comparison of Special Sensor Microwave Imager Wind Speed
Measurements Aboard the F-08 and F-10 Satellites During 1991

Visual Chemistry

Applications of a Charge-Coupled Device Video Camera to the Study of
Small Neural Nets

Enhancers and Suppressors of *bindsight*, a Gene that Programs
Morphogenesis in *Drosophila melanogaster*

Computer Simulation of the Higgs Searches with the GEM Detector

Cloning ETR1 Homologues in *Arabidopsis thaliana*

Design and Prototyping of GAMCIT: The Caltech Gamma-Ray Burst
Optical Transient Imaging Experiment

Isomerization of n-Butane Through Solid Super Acid

The Effect on RNA Polymerase Action by DNA-binding Rhodium
Complexes

Expansion of the San Onofre Neutrino Detector Array

Observation of Two Dimensional Bow Flow

Defining the Consensus Binding Site of *Drosophila melanogaster*
Giant Protein

Alteration of the Nd3 Gene to a Form which could be Expressed In the
Nuclear - Cytosolic Compartment

An Adaptable Set of Poisson Solvers

Affinity Cleavage in RNA Catalysis and Metabolism

Infrared Studies of the Center of the Galaxy

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Physical Mapping of Chromosomal 22 Bac Clones by Fingerprinting

The Role of Hemoglobin in Hydroxyl Radical Production

Aversion/Avoidance Learning in Locust and Crickets Utilizing
Olfactory Cues

The Biochemistry of FcRn

Studying the Response Behavior of Individual Pyramidal Cells to
Synchronous Synaptic Signals via Computer Modeling

Comparative Analysis of Avian and Mammalian Ciliary Neurotrophic
Factor (CNTF) Transcription

Infrared Image Analysis

Control of a Ducted Fan Engine

Characterization and Assembly of MIRLIN: Mid-Infrared Astronomical
Camera

Genes Involved in the Regulation of Methanol Oxidation Functions

Automating the Dome of the 24-Inch Telescope on Mount Wilson

Design and Construction of the X and Ku Band Transponders

Fiber Optic Strain Measurement

Molecular Mapping of Mutants Affecting the Abdominal Region of
Drosophila

Purification and Biochemical Characterization of *Drosophila*
Neuroglian

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The Linearization of Electrooptic Directional Coupler Modulators

Cyanin-Like Compounds of High Second Order Optical Non Linearity

Implementation of Time Reversed Inversion for Perfect
Reconstruction Filter Banks

Low-Background Studies of Radioactive Isotopes in Construction
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Purification of the CDC6 Protein through Affinity Chromatography

A High Resolution Study of the Reunion Event

The Three Dimensional Structure of a Filament

Pluto Fast-Flyby Spacecraft

Oligonucleotide Coupling on Glass Slide Using Linkers and their
Hybridization Properties

Radar Data Analysis for SIR-C Educational Project

Comparison of Language Learning in Neural Network Architectures to
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Identification of Proteins that Bind to the SH3 Domain of PSD-95

Gamma Ray Emission From Cen-A

A Model of Magnetic Field Decay in Solitary Neutron Stars

Black Hole Thermodynamics

Study of Differentiation of Traits Through Use of Artificial
Neural Networks

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Mode Mapping of Sapphire Resonator

Analysis of Conformational Preferences

Modeling DNA-Protein Recognition with Transition Metal Complexes:
The Synthesis of Rhodium bis
(4-guanidylmethyl-4'-methyl bipyridine) (phenanthrenequinone
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Analysis of Clonal Relationships among Floral Meristem Cells in the
Adult Flower of *Arabidopsis thaliana*

Optical Anisotropy of Block Copolymers

Automating the Dome of the 24-Inch Telescope on Mount Wilson

Long Period Variables In M33

Impact Pulse Analysis to Determine the Relative Effectiveness of
Various Tang Soo Do Techniques

Magnetic Dipole Effects on T1 Relaxation

The History of Caltech's Underrepresented Students

Infrared Observations of the Coma Cluster

Analysis of Simulated Quantal Release in a Locust Interneuron

Spectroscopic Evaluation of Interface Micro-Roughness in
GaAs/GaN P Single Quantum Wells

Structure and Stability of Ribosomal DNA Cloned in Bacterial
Artificial Chromosomes

Computer Design of Redox-Active Drugs

Near-Field Scanning Optical Microscopy: Feedback and Resolution
Study

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SURFSAT Ground Support Equipment and System Testing

Efficient Algorithms for Computing the First Factor of the Class Number for Cyclotomic Fields

Regulation of Leukemia Inhibitory Factor Receptor (LIFR) by Leukemia Inhibitory Factor (LIF)

A Proton NMR Investigation of Environmental Effects on the Rate of Rotation in the C-N Bond of Urea

The Winter Sea Ice Cover of the Weddell Sea, Antarctica, Observed by Microwave Radar

Mars '94 Oxidant Experiment (MOx) Equipment Testing: Behavior of New Technology Lithium Batteries for Micro-instruments on Mars

Screening and Isolation of New Pre-mRNA Splicing Mutants of *Saccharomyces cerevisiae*

Mass Spectrometric Fragmentation Mechanisms of Proferrioxamine Siderophores

Chemical Polishing of Si Surfaces and Deposition of Polymer on Si Using CHF_3 Plasma and their Applications

Screening and Isolation of New Pre-mRNA Splicing Mutants of *Saccharomyces cerevisiae*

Combinatorial Topology

Monte Carlo Simulation of Pulsar Populations

Expansion of the San Onofre Nuclear Reactor Detector Array

Purification of Embryonic-Myelin Basic Protein

Command Receiver and Power Subsystems, Engineering Model Fabrication and Test

Fractional Differential Operators as Annihilators

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The Separation of Superposition of Two Speech Signals

Design and Construction of a Robotic Manipulator

SURFSAT X- and Ka-Band Sub-System Engineering

Towards a Synthesis of Neocarzinostatin

2060 Chiron Surface Features

Development of a Standalone Radiation Hard Detector

Voter Learning in the 1980 Presidential Election

Observations of the Seasonal Sea Ice Cycle in the Arctic Ocean with
ERS-1 SAR

Surge and Stall in Axial Flow Turbofans

Glass-Forming Properties of Various Metallic Alloys

Application of Atomic Force Microscope for Nanoengineering

Synthesis of Intercellular Magnetic Resonance Imaging (MRI)
Contrast Agents for Embryonic Cell Lineage Analysis

SURFSAT S-Band Beacon Sub-System Engineering

A Survey for Millisecond and Relativistic Pulsar Systems in the
Galactic Plane

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Design and Prototyping of GAMCIT: The Caltech Gamma-Ray Burst Optical Transient Imaging Experiment

Development and Tests of Liquid Scintillators for the San Onofre Neutrino Experiments; Setup and Energy Calibration of a Neutron Detector

A Micro Machined Dew Point Hygrometer

Synthesis of a Membrane Impermanent MRI Contrast Agent: Combining Rhodamine Isothiocyanate and DTPA on Poly-d-Lys

Power Spectral Analysis of Surface Brightness Distribution of Interstellar Dust Clouds

Investigations of the Nuclear Equations of State Using 3+1-Dimensional Relativistic Hydrodynamics

The Synthesis and Ring-Opening Metathesis Polymerization (ROMP) of Functionalized 5-Cyclooctene Monomers

The Rotational Barrier about the C(O)-N Bonds of 1,1-Dimethylurea

Chemistry Animation Project Stereochemistry

The Artificial Headeye System

Mechanism of Enhanced TiO₂ Photodegradation of 4-Chlorophenol in the Presence Of Inorganic Oxidants

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Evolution of the Morphology of the Radio Galaxy Ngc1275 (3c84)

Image Enhancement and Tone Reproduction

Macintosh Data-Aquisition and Control System-Phase 2

Ohmic Contacts in Double-Layered Photocell

Computer Simulation of the Sun and its Interaction with the Earth:
Shadow Casting

Design Of Shock Testing Machine

Superoxide Dismutase Evolution and the Formation of Oxygen in the
Early Earth's Atmosphere

Ring-Opening Metathesis Polymerization of Low Strain Cycloolefins
With Ir(I) Catalysts

Identifying the Optical Counterparts of Radio Galaxies

Chemistry Animation Project

Lewis Acid Catalysis in Additions to Aldehydes

Comparison of Language Learning in Neural Network Architectures to
Learning in Human Subjects

Chemistry Animation Project

Determination of Spectral Breaks in Supernova Remnants and of Any
Active Sources Within the Supernova Remnants

The Improved Synthesis of 1,2-disilacyclopent-3-ene

Quantization Error of Sigma-Delta Modulation

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Synthesis of Substituted 1,4-Poly(1,1-diphenyl-methylene-1,3-butadienes) to be Deprotonated and Oxidized to Magnetically Active Materials

Synthesis of Nonlinear Optical Compounds for Attachment to Polymers

Spectroscopy in the Atmosphere of Jupiter

Spectroscopic Analysis of the B₂H₂ Cluster

Distance Properties in Graphs

The Design of Dimeric Metallointercalating Agents

A Closer Look at the Permanent Holographic Bragg Grating: Its Asymmetric Reflection Response

Detection of Laser Induced Plasma Fluorescence In Electrical Arcs

Thermal Transport in Mesoscopic Systems

Optical Bleaching in BaF₂ Crystal Calorimetry

Cloning of the Postsynaptic Density Protein, PSD-180, in Rat Brain

Production of Desert Varnish

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Parallelizing a Spectral Code in Fortran 77 Using Modular Fortran or Fortran M

Seeking Uniform Response in Barium Fluoride

Design and Prototyping of GAMCIT: The Caltech Gamma-Ray Burst Optical Transient Imaging Experiment

Proton Exchange Optical Modulators

Non-Linear Acoustic Effects and Control of the Rijke Tube

Flexible Links in Robot Manipulators

Identification of Genes Interacting with *Arabidopsis* Development

Synthesis and Characterization of Poly-(*para*)-phenylenevinylene (PPPV)

Cranial Neural Crest Migration in *Xenopus laevis*

TDHF Studies of Atomic Effects on Nuclear Cross-sections in Low Energy Region

Electrical and Electrochemical Characterization of the Titanium Nitride Electrode in the Alkali Metal Thermoelectric Converter

Brain Weight and Lifespan in Mustelids, Insectivores and Bats

Multiplexing of Volume Holograms in SHVOEs

X-Ray Crystal Structures of Hyperthermophilic Proteins

Synthetic Generation of a Particle Image Pair

Characterization of *Oligosaccharyl Transferase*

Magnetic Resonance Imaging Red Blood Cell Modelling Through Filled Blood-Cell Ghosts

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Optical Subsystems of the Palomar Stellar Interferometer

A Quantitative Model for the Effects of pH and 5-methylcytosine Substitution on the Energetics of Triple Stranded DNA

Mechanistic Investigations of *Oligosaccharyl Transferase*

SCOTSAT -Systems Engineering

Ubiquitin Assisted Analysis of Traslotion

Fine Dissection of Developmental Intermediates of Thymic Differentiation

Optical Design Considerations in the MARS 94 Oxidant Experiment

Studies of Electron-Molecule Collisions for Modeling Materials-Processing Plasmas

Design and Prototyping of GAMCIT: The Caltech Gamma-Ray Burst Optical Transient Imaging Experiment

Keeping a Spacecraft Flying with a Parallel Computer

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Stress Gradients and Reduction of Thermally Induced Stresses in
Spun-On Polymer Film

Photochemical Computer Box Model of Atmospheric Chemistry, and
an Application to Halogen-catalyzed Ozone Loss

Design and Prototyping of GAMCIT: The Caltech Gamma-Ray Burst
Optical Transient Imaging Experiment

Probing Tumor Cells for Possible "Address Molecules" in Cells

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X-ray Crystallographic Studies of the Rat Neonatal Fc-receptor
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Calcium Ion Channel Distribution in Nerve Cell Membrane

Pluto Fast-Flyby Spacecraft

An Experimental Study of Mixed Strategy

Characterization of the Diiron Core of Uteroferrin-WO₄ Complex

Resolution Limits of Tunneling Displacement Sensors Imposed by Current Fluctuations

Image Processing on Thermal Maps of Jupiter

Synthesis of Polyenal Precursors for Materials Research

Calculation of Isotopes of Helium and Hydrogen in Recent Flares

Synthesis of a Novel and Universal Photoreleaseable Caging Compound

Hindsight Function in the *Drosophila melanogaster* Eye

Rheo-Optical Measurements of the Complete Normal Stress Tensor in Homopolymer Melts

Several Interesting Problems about Random Sequence

Pluto Fast-Flyby Spacecraft

Planform Visualization of Low Speed Flow Around a Rotating Disk

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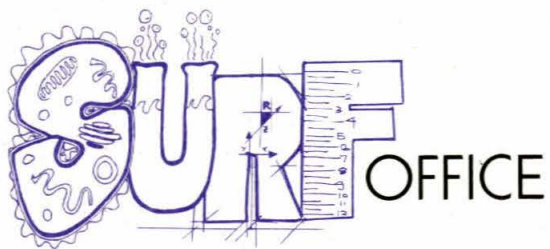
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