The California Tech

VOLUME CV, NUMBER 29 PASADENA, CALIFORNIA JUNE 1, 2004

Pixar Scientist Links Math with Animation

By CHRISTINE CHANG

When many people think about mathematics, they remember the droning voice of a high school teacher, the bewildering complexity of cryptic symbols and the countless hours spent attempting to understand it all. Departing from these experiences, they enter the world believing that mathematics can only apply to boring careers. Tony DeRose, however, utilizes mathematics everyday in his job, which is far from dull.

DeRose earned a Bachelor of Science degree in both Physics and Computer Science and spent many years teaching computer science as a professor at the University of Washington. However, after many years of teaching, he entered an industry that few would ever connect with mathematics and computer science: the film industry.

Currently, DeRose works at Pixar Animation Studios, the creators of such film hits as "Toy Story," "Monster's, Inc.," and most recently "Finding Nemo." The company has already earn multiple Oscar awards for its innovative and groundbreaking animated films, as well as for its short films. DeRose himself helped in the creation of the Oscar winner "Geri's Game."

In the making of these films, much planning using both mathematics and computer programming occurs over the course of four years. In the final presentation of the film, however, these painstaking hours of work are often hidden behind colorful characters and an entertaining plot.

"If you find yourself thinking about the technology, then we've failed," said DeRose.

Though not obvious, however, much work is placed into each film which is created. Four years before a film is revealed to the public, the director molds and refines the idea for the story before pitching the idea to the company.

Once the company agrees to fund the project, the story is made more concrete through the creation of storybooks which contain images of important events. Then the editorial board steps in to put the film on reel. The editorial board repeats this process four to five times before real digital production is even begun.

Meanwhile, the art department generates concept art which determines the mood of the film. The art is then transformed into three-dimensions through the use of world modeling. During this step, the modelers may use either a computer program called Maya or may use clay to physically sculpt a replica. Touch probes then digitize these physical sculptures.

The next step in the production process is articulation. "Articulation is creating the

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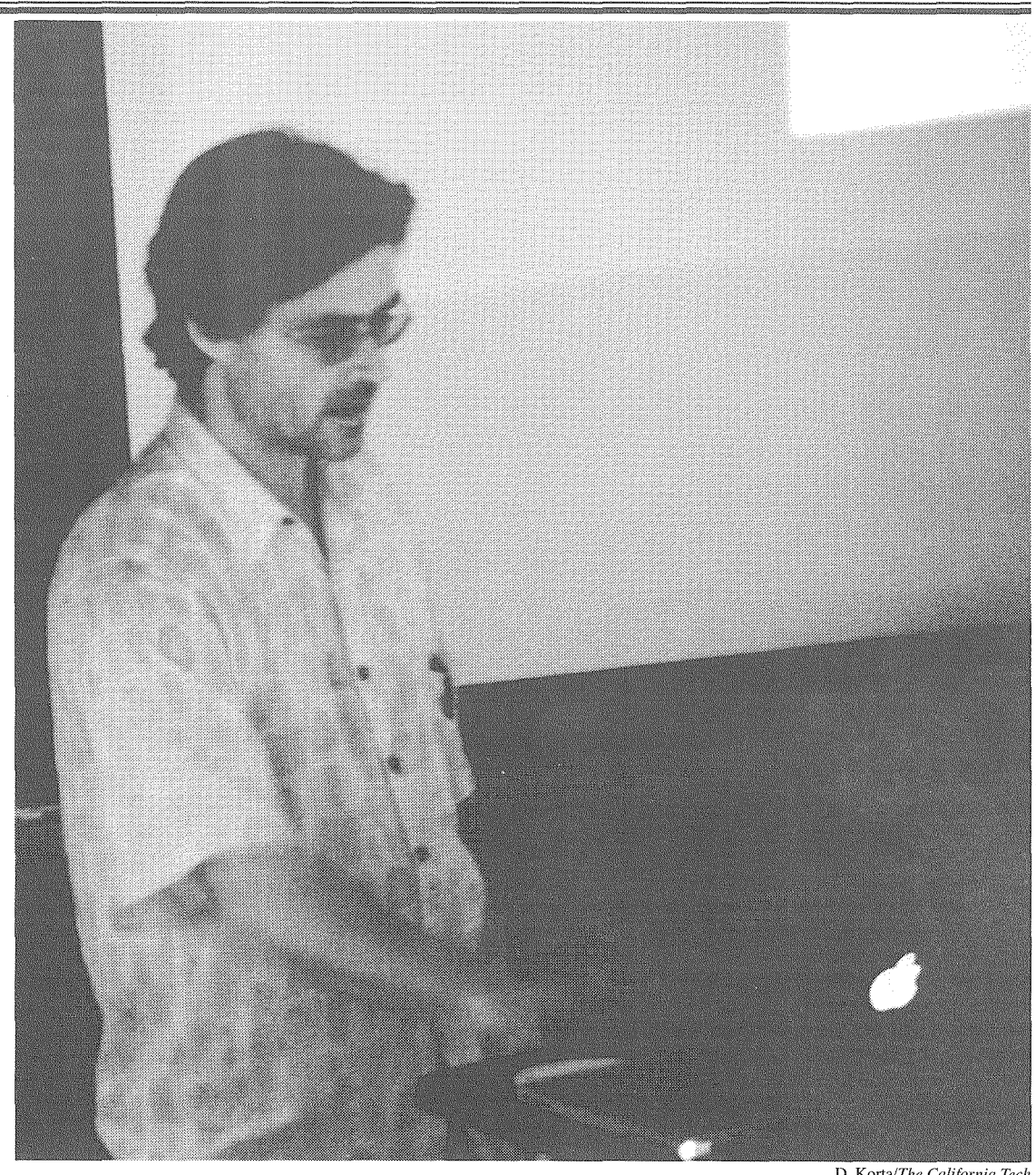

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Pixar employs many scientists like Tony DeRose to design the models that move its characters. Animators use the models to design the scenes of the movies.

California Fault Lines Mapped; Local Landscape Shows Activity

By K. SZWAYKOWSKA

On Thursday at eight in the evening, Dr. Sue Hugh of the US Geological Survey faced a large audience in Baxter auditorium to give a talk titled "Finding Fault in Los Angeles". Unlike many of the other lectures seen on the Caltech campus, this one involved little obscure science and did not attempt to explain complicated phenomena at any more than the most basic possible level.

Dr. Hugh kept on the light and humorous side as she explained the location of various faults in Southern California, the area that, in her own words, "we all know and love."

Many California residents are reasonably concerned with earthquakes and earthquake safety; though construction over active fault zones is now forbidden by law, many buildings, including the JPL campus, are built over and around major faults and thus are quite vulnerable to earthquake damage.

This also means that most major earthquakes also take their toll on human life: the Northridge Earthquake in 1994 killed 51 people and injured over 9000; the 1971 earthquake near San Fernando caused at least 58 deaths and 2000 injuries and the list goes on. This perhaps accounts for the impressive turnout at the lecture, though Dr. Hugh soon made it interesting in its own right.

In a short introduction to the causes of earthquakes in general, Dr. Hugh explained, very basically, the three different kinds of faults which may occur when tectonic plates meet on the earth's surface: normal, thrust and strike-slip faults. Each results from a different overlap of the plates and earthquakes occur when plates rearrange along these faults.

The entire coast of California is, as Dr. Hugh explained, a very active fault zone; the San Andreas Fault stretches 1200 km, over much of the coast of California, with a large bend in the Los Angeles area, which Dr. Hughes explained, causes stress on the surrounding land. The Los Angeles area is laced with numerous smaller faults, such as the San Gabriel Fault zone, the Sierra Madre fault zone and the Raymond fault, located near to JPL.

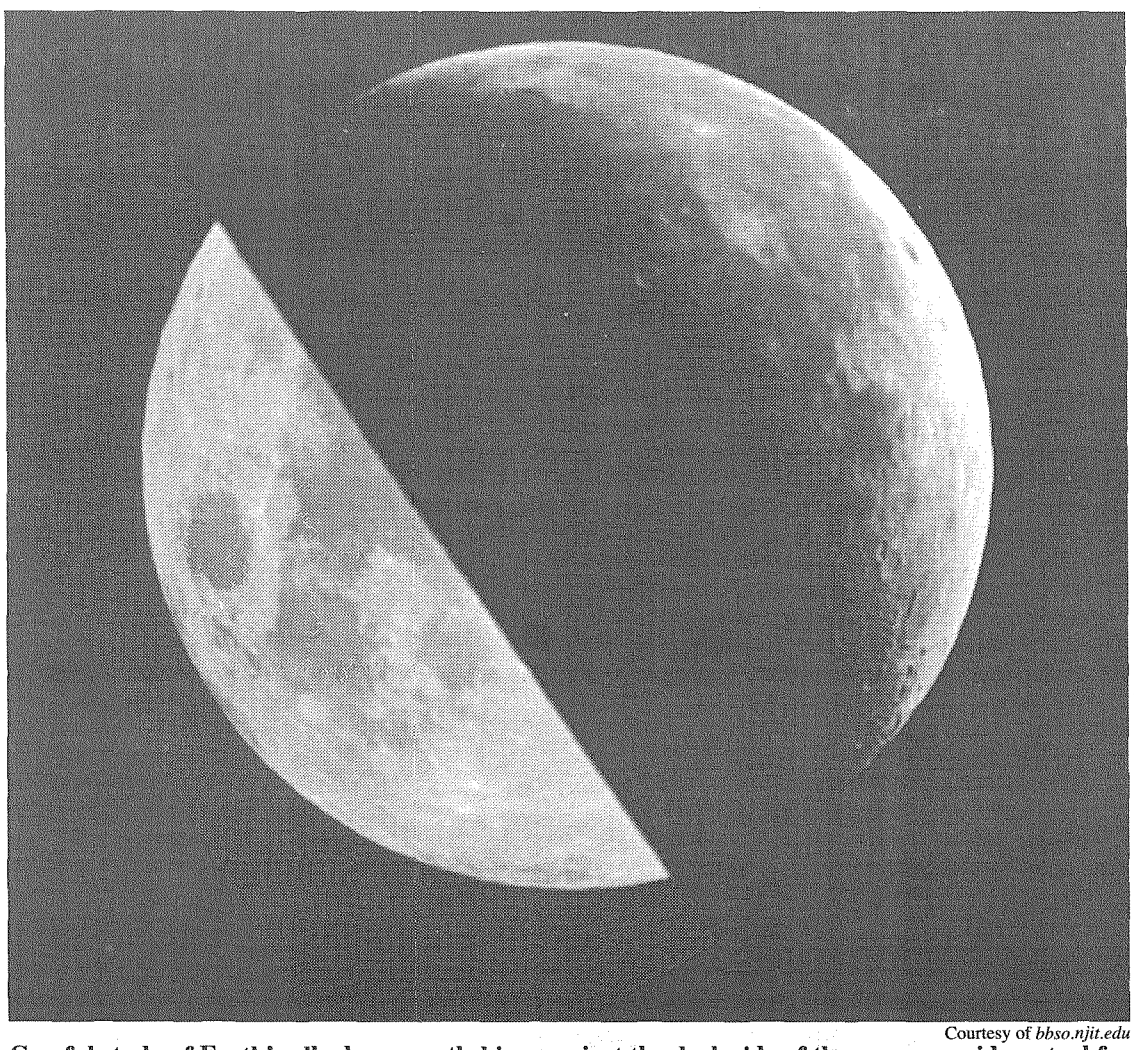
The lecture included a picture tour of many of these faults, photographed in familiar locations around the LA area. Dr. Hugh showed, surprisingly many innocent-looking hills and short ridges, which the everyday observer hardly notices, are traces of faults and signs of flourishing earthquake activity to a geologist.

For example, a parking lot elevated slightly from a nearby road, or an unusually steep hill in the

Continued on Page 8, Column 1

D. Korta/*The California Tech*

Dr. Sue Hugh explains the project she heads to map the California fault lines. Hugh remarked on the ease with which a trained eye can spot the faults, even from the air.



Courtesy of *bbso.njit.edu*

Careful study of Earth's albedo, or earthshine, against the dark side of the moon provides a tool for researchers to measure climate changes.

Da Vinci Earthshine Technique Helps Study Climate Changes

By ROBERT TINDOL

PASADENA, Calif.-Scientists who monitor Earth's reflectance by measuring the moon's "earthshine" have observed unexpectedly large climate fluctuations during the past two decades. By combining eight years of earthshine data with nearly twenty years of partially overlapping satellite cloud data, they have found a gradual decline in Earth's reflectance that became sharper in the last part of the 1990s, perhaps associated with the accelerated global warming in recent years.

Surprisingly, the declining reflectance reversed completely in the past three years. Such changes, which are not understood, seem to be a natural variability of Earth's clouds.

The May 28, 2004, issue of the journal *Science* examines the phenomenon in an article, "Changes in Earth's Reflectance Over the Past Two Decades," written by Enric Palle, Philip R. Goode, Pilar Montanes Rodriguez and Steven E. Koonin. Goode is a distinguished professor of physics at the New Jersey Institute of Technology (NJIT), Palle and Montanes Rodriguez are postdoctoral associates at that institution and Koonin is professor of theoretical physics at the California Institute of Technology.

The observations were conducted at the Big Bear Solar Observatory (BBSO) in California, which NJIT has operated since 1997 with Goode as its director. The National Aeronautics Space Administration funded these observations.

The team has revived and modernized an old method of determining Earth's reflectance, or albedo, by observing earthshine, sunlight reflected by the Earth that can be seen as a ghostly glow of the moon's "dark side"-or the portion of the lunar disk not lit by the sun.

As Koonin realized some 14 years ago, such observations can be a powerful tool for long-term climate monitoring. "The cloudier the Earth, the brighter the earthshine and changing cloud cover is an important element of changing climate," he said.

Precision earthshine observations to determine global reflectivity have been under way at BBSO since 1994, with regular observations commencing in late 1997.

"Using a phenomenon first explained by Leonardo Da Vinci, we can precisely measure global climate change and find a surprising story of clouds. Our method has the advantage of being very precise because the bright lunar crescent serves as a standard against which to monitor earthshine and light reflected by large portions of Earth can be observed simultaneously," said Goode. "It is also inexpensive, requiring only a small telescope and a relatively simple electronic detector."

By using a combination of earthshine observations and satellite data on cloud cover, the earthshine team has determined the following:

Earth's average albedo is not constant from one year to the next; it also changes over decadal timescales. The computer models currently used to study the climate system do not show such large decadal-scale variability of the albedo.

The annual average albedo declined very gradually from 1985 to 1995 and then declined sharply in 1995 and 1996. These observed declines are broadly consistent with previously known satellite measures of cloud amount.

The low albedo during 1997-2001 increased solar heating of the globe at a rate more than twice that expected from a doubling of atmospheric carbon dioxide. This "dimming" of Earth, as it would be seen from space, is perhaps connected with the recent accelerated increase in mean global surface temperatures.

2001-2003 saw a reversal of the albedo to pre-1995 values; this "brightening" of the Earth is most likely attributable to the effect of increased cloud cover and thickness.

These large variations, which are comparable to those in the earth's infrared (heat) radiation observed in the tropics by satellites, comprise a large influence on Earth's radiation budget.

"Our results are only part of the story, since the Earth's surface temperature is determined by a balance between sunlight that warms the planet and heat radiated back into space, which cools the planet," said Palle. "This depends upon many factors in addition to albedo, such as the amount of greenhouse gases (water vapor, carbon dioxide, methane) present in the atmosphere. But these new data emphasize that clouds must be properly accounted for and illustrate that we still lack the detailed understanding of our climate system necessary to model future changes with confidence."

Goode says the earthshine observations will continue for the next decade. "These will be important for monitoring ongoing changes in Earth's climate system. It will also be essential to correlate our results with satellite data as they become available, particularly for the most recent years, to form a consistent description of the changing albedo. Earthshine observations through an 11-year solar cycle will also be important to assessing hypothesized influences of solar activity on climate."

Montanes Rodriguez says that to carry out future observations, the team is working to establish a global network of observing stations. "These would allow continuous monitoring of the albedo during much of each lunar month and would also compensate for local weather conditions that sometimes prevent observations from a given site."

BBSO observations are currently being supplemented with others from the Crimea in the Ukraine and there will soon be observations from Yunnan in China, as well. A further improvement will be to fully automate the current manual observations. A prototype robotic telescope is being constructed and the team is seeking funds to construct, calibrate and deploy a network of eight around the globe.

"Even as the scientific community acknowledges the likelihood of human impacts on climate, it must better document and understand climate changes," said Koonin. "Our ongoing earthshine measurements will be an important part of that process."

Alumni Association Honors Benefactors

By JILL PERRY

PASADENA, Calif. - How do you become a Caltech alumnus without taking years of physics, mathematics, chemistry and biology? You do outreach programs that benefit 5,000 business leaders a year, you support field trips for alumni, or you serve as an enthusiastic advocate of undergraduate research for 40 years.

These are a few of the accomplishments of this year's class of new honorary members of the Caltech Alumni Association. They are Gaylord "Nick" Nichols, director of Caltech's Industrial Relations Center; Ed Stolper, Caltech's acting provost, chair of the Division of Geological and Planetary Sciences and the Leonhard Professor of Geology; and Tom Tombrello, chair of the Division of Physics, Mathematics and Astronomy and Kenan Professor and professor of physics.

They will be feted at the Honorary Alumni Dinner on Friday, June 11, at Caltech's Athenaeum where they will receive a framed certificate of Honorary Membership in the Alumni Association. Including this year's trio, 89 people have been named honorary members of the Alumni Association.

"The Alumni Association grants Honorary Membership to those in the Caltech family whose extraordinary and sustained efforts have positively influenced the Institute or the Alumni Association," said Stephanie Charles, who chaired the Honorary Alumni Nomination Committee.

Nichols has been associated with Caltech and the Jet Propulsion Laboratory for 46 years and has worked at Caltech for more than 20 years. As head of the Industrial Relations Center, he brings 1,400 business leaders to campus to attend classes and events and arranges to have classes presented to 3,600 additional people at their companies or off site every year.

The Industrial Relations Center has dozens of course offerings and has raised Caltech's profile among major corporations. Nichols was instrumental in fostering the MIT/Caltech Enterprise Forum in which technology-based companies and issues are presented to the Caltech community, the financial community and the entrepreneurial community.

Nichols also opens up his Industrial Relations programs to students free of charge and several students have used the courses as stepping-stones to internships, jobs and other endeavors.

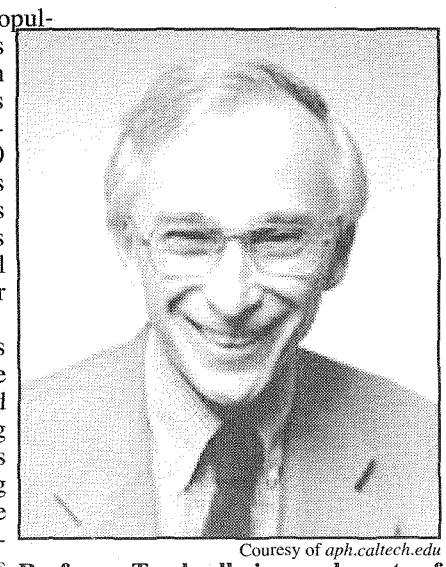
Ed Stolper has been chairman of the Division of Geological and Planetary Sciences for almost 10 years. During this time, the number of majors and enrollments in the division have increased manyfold and the division is known across campus as having among the happiest and most engaged students; a good part of this is attributed to the open policies and close relationships between students and faculty led by Stolper as division chairman.

In addition, his division maintains strong relationships with alumni through Alumni College, field trips with the Associates and alumni and other programs that have been developed during his time as chairman.

Tom Tombrello has been an enthusiastic supporter of undergraduate research since he arrived on campus more than 40 years ago. He served as a Summer Undergraduate Research Fellowships (SURF) program mentor and financial supporter when the program began, was a charter member of the SURF Administrative Committee and continues to review proposals and provide counsel to the program.

Tombrello initiated a course many years ago to provide undergraduate research opportunities for top first-year physics students. He subsequently expanded the program to include high school students with high potential for admission to Caltech and through that effort was able to attract some outstanding students to Caltech.

He received the Feynman Teaching Award as well as two Associated Students of Caltech Teaching Awards. Along with Nichols, Tombrello was instrumental in setting up the annual Law & Technology mock trials which Caltech hosts with Loyola Law School.



Couresy of *aph.caltech.edu*

Professor Tombrello is an advocate of undergraduate research.

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VOLUME CV, NUMBER 29

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The *Tech* is published weekly except during vacation and examination periods by the Associated Students of the California Institute of Technology, Inc. The opinions expressed herein are strictly those of the authors and advertisers.

Letters and submissions are welcome; e-mail submissions to *tech@tech.caltech.edu* as *plain-text* attachments, including the author's name, by Friday of the week before publication. Sorry the *Tech* does not accept anonymous contributions. The editors reserve the right to edit and abridge all submissions for any reason. All written work remains property of its author.

The advertising deadline is five p.m. Friday; alladvertising should be submitted electronically or as camera-ready art, but the *Tech* can also do simple typesetting and arrangement. All advertising inquiries should be directed to the business manager at *business@tech.caltech.edu*. For subscription information, please send mail to "Subscriptions."

Caltech Grants Upper Class Merit Awards to Outstanding Scholars

By ROSEMARY LARRANAGA

The Faculty Scholarships and Financial Aid Committee is pleased to announce the recipients of the 2004-2005 Caltech Upper Class Merit Awards. Upper Class Merit Awards are based on outstanding scholastic achievement, research and related endeavors.

These awards are made possible through contributions from generous donors who have endowed the competition. Scholarships for the 2004-05 academic year will be provided by the Stuart Foundation (Carnation Merit Scholarships), Lew and Edie Wasserman (Caltech Upper Class Merit Awards), the John Stauffer Scholarship, earmarked for Chemistry/Chemical Engineering majors, and the Rosalind W. Alcott Scholarship.

The Committee awarded more than one million dollars to this year's recipients. The following students will receive awards ranging from three-quarters tuition to full tuition plus room and board for the next academic year:

Carnation Merit Award
Vincent Auyeung
Arjun Bansal
Adam D'Angelo
Wei Lien Dang
Mithun Diwakar
Christopher Franco
Yiyang Gong
Viviana Gradinaru
ChongQin Guo
Judith Hubbard
Patrick Hummel
Matthew Johnston
Daniel Koslover
Tony Lee
Jeremy Leibs
Jennifer Li
Binghai Ling
Marin Markov
Clare Moynihan
Timothy Nguyen
Karin Oberg
Yingkai Ouyang
Weronika Patena
Yan Qi
Joan Karen Sum Ping
Tom Sze
Neil Tiwari
Jing Xiong
Mehmet Yenmez

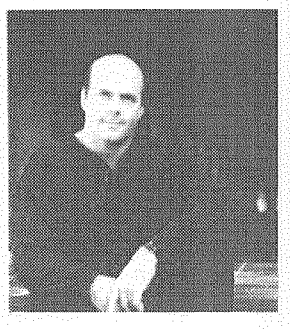
Caltech Upper Class Merit Award
Pavel Batrachenko
Brant Carlson
Elena Fabrikant
Jenny Fisher
Lisa Fukui
Joseph Gonzalez
Lea Hildebrandt
Dorota Korta
EthelMae "Vicki" Loewer
Po-Ru Loh
Galen Loram
Ryan Olf
Laura Pruitt
Brian Underwood
Joe Wasem
Trevor Wilson
Phillip Zukin

John Stauffer Merit Scholarship
Xiao Peng

Rosalind W. Alcott Merit Scholarship
Christina Dwyer
Christopher McClendon
Bin Wu

Congratulations to this Year's ASCIT Teaching Award Recipients!

Professors/Lecturers:



Colin Camerer
Economics

K. Mani Chandy
Computer Science

Alan Hajek
Philosophy

Not Picutred:
Kayoko Hirata, Japanese
Feng-Ying Ming, Chinese

Teaching Assistants:

Victor Tsai
Planetary Science

Not Picutred:
Dave Goulet, Applied and Computational Math
Mihai Stoiciu, Math

Thank you for your dedication to teaching!

courtesy of *www.herothemovie.com*

Director Yimou Zhang's inaugural kung fu movie, *Hero,* is a cleverly told story about how one man defeats three assassins who sought to murder the most powerful warlord in pre-unified China.

A *Heroic*, if not Victorious Effort

By HARRISON STEIN

The glory of Asian cinema has been largely ignored since the heyday of director extraordinaire Akira Kurosawa, as the average American couldn't tell Zhang Ziyi (famous Chinese actress) apart from Wang Zhizhi (Chinese NBA player). However, everything changed with the release of 2000's earth shattering *Crouching Tiger, Hidden Dragon* as Western audiences finally began to appreciate the beauty of Chinese and Japanese art, leading to a cinematic revolution.

In recent years, American audiences have been treated to a gluttony of recent Asian masterpieces such as *Ringu*, *Spirited Away*, and *Princess Mononoke* that would have been neglected ten years ago. Thanks to samurai aficionado Quentin Tarentino and his enormous wallet, American audiences will be fortunate enough to see Yimou Zhang's 2002 epic *Ying Xiong* (or *Hero*) in theaters later this year. Luckily, I was able to view a sneak preview of this Chinese classic this past Friday at a special screening provided by the Caltech C.

Unlike most Chinese films that reach American theaters, Hero actually has an engrossing and challenging storyline to complement its all-out swordplay and emotional scenes depicting honor, valor and integrity. Modeled around Kurosawa's overrated but revolutionary *Roshomon*, *Hero* is the story of a nameless warrior (Jet Li), in the midst of a war amongst China's seven kingdoms, who mysteriously slays the three finest warriors of the rival Zhao kingdom.

The Qin Emperor, who was targeted by the three Zhao assassins for ten years, congratulates Nameless by allowing the warrior to come within ten paces of him. Nameless then tells how he killed Sky (Donnie Yen), and then defeated assassin lovers Broken Sword and Flying Snow (Tony Leung Chiu Wai and Maggie Cheung). However, after Nameless tells his sweeping tale, we learn Nameless has ulterior motives, and consequently, his story is shockingly inaccurate with never-ending lies. We hear the same account from various points of view, and unlike in *Rashomon*, we eventually learn what actually happened, in an enormously satisfying conclusion.

Hero's twisting and turning plot is its most memorable and unparalleled aspect, but the film is also a compelling action/drama. The love story of Broken Sword and Flying Snow is very endearing, albeit a little tacky, and the dilemmas facing the two assassins are infinitely intriguing. The tension between the emperor and the nameless warrior slowly builds until a striking climax wraps the movie into a nice little package. The different tales are cleverly distinguished by colors, as the assassins Broken Sword and Flying Snow wear different colored clothing in the three or four different stories. The beautiful imagery allows the viewer to recognize when the stories change without disturbing the cinematic mood.

Unfortunately, the action scenes are a little underwhelming because the style of fighting, flying warriors made so famous in *Crouching Tiger, Hidden Dragon* is now rather stale. *Crouching Tiger's* fighting sequences were unrealistic, but because they were so beautifully filmed the audience was able to suspend its disbelief and enjoy the spectacle. However, the action scenes in *Hero* are laughable and the film's blatant disregard for the laws of physics becomes rather unnerving. Some of the battles, such as a random tussle between Moon and Flying Snow, are superfluous and I was hardly impressed with the "mind-battles" Nameless has with various warriors before he actually fights them. Nonetheless, some of the scenes are quite moving, including a poignant episode where a Zhao calligraphy shop is interrupted by a barrage of Qin arrows.

The acting in *Hero* is sporadically excellent and at other times completely implausible, but as a whole, the performances are strong enough that they don't detract from the beautiful story. Jet Li is rather wooden as the nameless warrior who ultimately becomes an unlikely hero but Wai and Cheung do a fantastic job of portraying the two Zhao assassin lovers, Broken Sword and Flying Snow. Their performances are enhanced by the fact that in each story, the two characters have completely different roles--in one account, they are bitter and jealous ex-lovers, while in a second story, they are madly in love and willing to die for each other.

Even though *Hero* is not as good as film is advertised (it is rated 166 on the Internet Movie Database list of the all-time top 250 films, a list that doesn't include *Chicago*, *Field of Dreams* nor *A Beautiful Mind*), it is an excellently written period piece with stunning performances, important messages, and interesting fights. *Hero* is not one of the best Chinese films ever made, but it's far superior to brainless American blockbusters, and hopefully, the film will find a wide audience when it's released in August. It's definitely worth a look!

*** out of ****

courtesy of *www.herothemovie.com*

Minutes

Caltech Ballroom Dance Club Party: Our end of term party will be held Saturday, June 5 in Winnett Lounge. We will begin with a mini-lesson on Merengue at 8:30, followed by general dancing from 9 pm until you can't dance anymore. The price is FREE, and refreshments will be provided. As with all our parties and classes, no partner or previous dance experience is necessary, just bring yourself and join us for the good times!

Also summer ballroom classes are coming up;
Salsa dance class: Offered jointly by the Caltech Ballroom Dance and Salsa Clubs. Beginning salsa lessons will be taught Wednesdays from June 16th through August 4th. Class is held in Winnett Lounge from 8:30 - 10 pm, and the cost is $7 per class or $40 for the entire 8 week series. No partner or previous experience is necessary.

Lindy Hop (Swing) Class: Classes in beginning Lindy Hop will be taught for eight Mondays beginning June 14th through August 2nd, from 8:30 - 10 pm in Winnett Lounge. The cost for Caltech students and SURFers is $6 per class or $40 for the entire series; for nonstudents the pricing is $8 per class, $56 for the series. No partner is necessary and refreshments will be served.

CalTech Grad Students...
Stuck here doing research on your dissertations? Then take a break from the typical 'all nighter'...on Thursday, June 17, join us for the **FREE LACMA Overnight Tiki Till Dawn Party** which opens the museum to party-goers beginning at 7 pm and continuing till 7 am the following morning.
In addition to free admission to exhibitions including Beyond Geometry and Inventing Race, the party features live music, DJ Diabetic, a sneak preview of the new Sony Pictures Classics surf film Riding Giants, and appearances by L.A. authors including Gary Baseman signing Dumb Luck, Robbie Conal signing Art Burn, Sandow Birk signing Dante's Inferno, and Shag signing Tiki Drinks, Shag's Around the World in 80 Drinks, and Shag Party.
Party fun also includes films, interactive graffiti murals, live improv, no-host barbecue and tiki bar, and a random drawing to award a lucky winner two free plane tickets to anywhere in the world that Air France flies. A custom-painted motor scooter created by artist Shepard Fairey will also be the featured prize in a summer-long silent auction, proceeds of which will benefit LACMA art education programs for at-risk youth.
We wanted to send our friends at CalTech a special, advance invitation to our latest event given the raving success of LACMA's first free "all-nighter" - Cabaret LACMA, which drew nearly 9,000 party insiders!

Caltech's 2nd annual "Travel Fair" will take place on Wednesday June 16th from 11:00 to 2pm in front of the Chandler Dining Hall. Come to meet and greet the travel and pcard departments and our many travel vendors. There will be music and a barbeque meal will be available to purchase at Chandler. Prizes will be donated by some of our top vendors, (winners must be students, staff or faculty of Caltech.) Come and enjoy the sunshine and the fun!

Summer Work Study: Information and applications for 2004 Summer Work Study are available in the Financial Aid Office. If you are interested in Summer Work Study, please submit the required application as soon as possible, but no later than June 1, 2004. Your entire financial aid application must be complete by June 1, 2004 in order to be considered for Summer Work Study. If awarded, the work study funding will begin July 1, 2004.

Racquetball Challenge Court. Wednesdays, 5:30 - 8 PM, Braun Gym. Show up to the Racquetball club's challenge court and take on anyone here. We usually have two reserved courts, and we play winner stays on. Challenge yourself and a worthy opponent! Everyone is welcome and we normally have all skill levels show up (including beginners). And if you don't know how to play, look for our next monthly club sponsored lesson. You can borrow the necessary equipment from the front desk. See you there!

Submit to the *Totem*! The *Totem* is now accepting submissions for the 2004 edition the the literary magazine. Anyone in the Caltech community can submit their poetry, short stories, artwork and/or photography to the *Totem*. Please send your work by email (*totem@its.caltech.edu*), or by campus mail (MSC 292).

SCHOLARSHIPS

The **American Association of Japanese University Women** is currently accepting applications for their 2004 scholarship program. Female students enrolled in accredited California colleges and universities, who will be junior, senior or graduate student by Fall 2004 are eligible to apply. You may pick up an application in the Financial Aid Office or e-mail them for more information. E-Mail Address: *aajuw@worldnet.att.net* The deadline for this scholarship is September 30, 2004.

The Ayn Rand Institute presents the **6th Annual Essay Contest on Ayn Rand's Novel "Atlas Schrugged."** There is one $5,000 scholarship and two second prizes of $1,000. There are also third, finalist, and semifinal-

Continued on Page 6, Column 1

2004 McKinney Competition Winners

The McKinney Committee of the Caltech Literature Faculty is pleased to announce the winners in the 2004 contest for excellence in writing. In the category of non-fiction essay, the prize is awarded to Wensi Xu. Rebecca Streit is the winner in the poetry competition. The award in prose fiction goes to Elliott Karpilovsky.

Honorable mention is given to Eva Murdock, Jeremy Gillula, John Sadowski, Michael Villet, and Samuel Thomsen.

2004 Hallett Smith Prize

The prize in the Hallett Smith Competition (for the finest essay devoted to Shakespeare) was won jointly by Nicholas Rupprecht and Chris Meagher.

Spitzer Space Telescope Sets Infrared Eyes on Dark Matter

By WHITNEY CLAVIN

Ten years ago, a group of astronomers set out to find invisible, or dark, matter in the outer fringes of our galaxy. Long postulated to make up a significant chunk of our universe, dark matter may be partly made up of massive, celestial objects hiding in the halos of galaxies. The astronomers spent six years scanning a large patch of sky and sensed something, but they weren't sure if they were really seeing dark matter or a different class of nearby objects getting in the way.

Now, NASA's Spitzer Space Telescope has set its infrared eyes on this mystery matter and verified that at least one of 17 invisible objects observed years ago lies within the body of our Milky Way galaxy, thereby supporting the latter hypothesis. More observations are needed to draw definitive conclusions; nonetheless, the findings illustrate the power of Spitzer to finally put together the pieces of this decade- old puzzle.

"Historically, searches for unseen matter have been part of the justification for Spitzer," said Dr. Michael Werner, the Spitzer project scientist at NASA's Jet Propulsion Laboratory, Pasadena, Calif., and an investigator for the new research. "We are very excited about these initial results."

Matter as we know it doesn't add up to all the matter in the universe. At least 10 times more unseen, or dark, matter exists than known matter. Most dark matter is exotic, made up of something other than everyday atoms. But the rest of it may take the form of celestial objects that are too faint to see because they're very cool. These objects, referred to as "massive compact halo objects," or "machos," are thought to be lurking in the far reaches, or halos, of galaxies. They might include black holes and failed stars called brown dwarfs.

Beginning in 1992, Dr. Charles Alcock, who was then at the Lawrence Livermore National Laboratory, Calif., and is now at of the University of Pennsylvania, Philadelphia, and his colleagues went on a hunt for machos. Rather than scan for the objects themselves, the team looked for the objects' gravitational tug on starlight emanating from behind them. In this technique, called gravitational microlensing, a lens object (the invisible matter) causes the source object (a star) to brighten for a brief period of time. Alcock and his team surveyed 12 million stars for these events in the nearby Large Magellanic Cloud, which lies on the far side of our galaxy halo. They detected 17.

But, based on the predicted numbers of faint stars in our galaxy, the astronomers had expected to see much fewer than 17. Either there is a significant amount of dark matter in the galaxy halo, or there is invisible matter in our own galaxy that cannot yet be understood. Either way, the findings challenged scientific descriptions of matter.

That's where Spitzer comes in. Because it can see objects that are too cool to be seen with other telescopes, it may be able to detect the heat from many of these invisible lenses. To test this ability, a group of astronomers, including Alcock and Werner, and led by Dr. Hien Nguyen of JPL, used Spitzer to observe the macho event referred to as MACHO-LMC-5. This event is the only one of its type that could be seen by NASA's Hubble Space Telescope. Data obtained by Alcock and others using Hubble beginning in 2001, and most recently analyzed by Dr. Andrew Gould of Ohio State University, Columbus, suggest that the lens object for MACHO-LMC-5 is a low-mass star about 1,500 light-years away within our galaxy's disc.

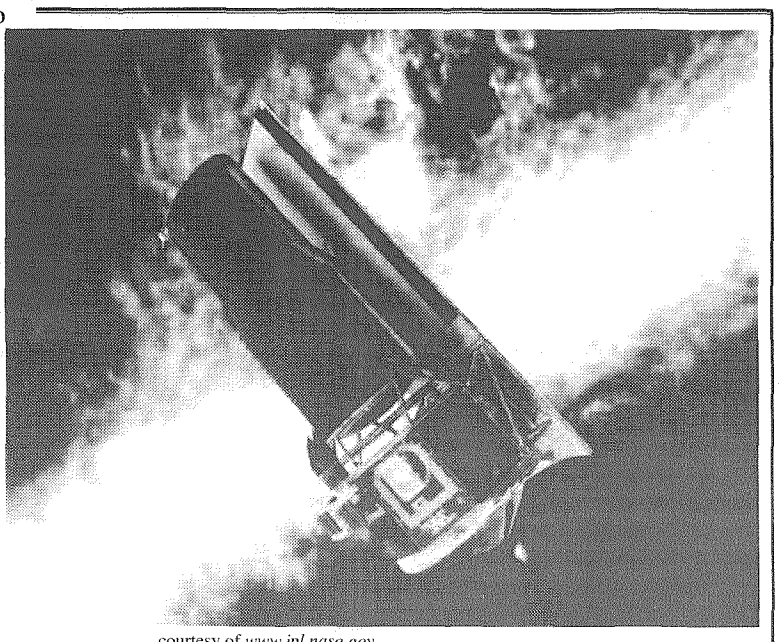
The new Spitzer data for this event independently confirm this finding. "By luck, Hubble was able to see the lens in one of 15 events it looked at, whereas Spitzer should be able to see many more, if these microlensing events are indeed caused by nearby cool objects," Nguyen said.

Nitya Kallivayalil, a graduate student at the University of Pennsylvania, with critical insight from Dr. Daniel Stern of JPL, carefully measured the brightness of the lens using the Spitzer data. Dr. Brian M. Patten of the Harvard-Smithsonian Center for Astrophysics, Cambridge, Mass., used these measurements to establish that the lens is a very low mass, faint star. "The data are fantastic," said Kallivayalil. "When Brian showed us that they confirmed the nature of the star, we were ecstatic."

Added Patten, "With this new capability, we'll be able to determine the properties of many more lenses, and determine their contribution to dark matter in our galaxy."

The team of astronomers recently collected data for four additional macho events and have plans to study nine more. For more information about the Spitzer Space Telescope, visit *http://www.spitzer.caltech.edu.*

The Spitzer Space Telescope is managed by JPL for NASA's Office of Space Science, Washington. Science operations are conducted at the Spitzer Science Center at the California Institute of Technology in Pasadena. JPL is a division of Caltech.



courtesy of *www.jpl.nasa.gov*
An artist's concept of the Spitzer Space Telescope.

Letter to the Editor: *Gender Harassment Survey Article in* The Tech *Erroneous*

Dear Editor,

The GSC/WEST survey committee would like to thank *The Tech* for its article, "Gender Harassment Survey Disappoints," which ran in the May 10, 2004 edition. We appreciate the objective and informative manner in which the article was written, including the author's careful reminder that questions pertaining to gender harassment issues were only a small portion of a larger and more general quality of life survey.

The article contained a few errors, which we would like to correct. The graphic on page two identified the results as coming from the "GSC Quality of Life Gender Harassment Survey." The survey is a joint project of the GSC and WEST, and the charts should have been credited as such. This point was properly noted on page one.

The overall survey response rate was 57%, not 53% as stated in *The Tech*. Also, the article reports that the response had "no significant bias based on gender or nationality." Although women represent 27% of the graduate student body, they composed 33% of the survey population. 52% of men completed the survey, while the response rate from women was 72%. However, as the results for women and men were separated throughout the Gender Harassment report, the higher percentage of female respondents did not materially affect any results.

Professor Michael Alvarez's assistance throughout the survey project has been invaluable; he aided in the design of the survey instrument and has made himself available for consultation on several survey issues of a technical nature, including issues that arose in the preparation of the Gender Harassment report. However, he did not participate in the actual analysis of data as was indicated on page one.

Finally, the last paragraph of the article stated that, "Most harassment experienced by graduate students takes place in laboratory groups." The survey itself did not contain any questions concerning the location in which the various harassing behaviors reportedly occurred. Indeed, one of the survey committee's recommendations for follow-up investigation is that data must now be collected regarding who is committing the harassing behaviors and where those behaviors are taking place. With the Institute Gender Harassment Task Force due to release its recommendations for Caltech action soon, we anticipate they will present a plan for obtaining precisely that information.

Signed,
Cynthia Collins, Heather Cox, Steve Practo

Help *The Tech* with its annual year-end issue of *The Rivet! The Rivet* is a spoof on a well-known magazine or newspaper. In the years past, we have brought you our version of *Vogue* and *The Onion*. This year, we'd like to parody *Martha Stewart Living* magazine. This is generally a very "preppy" magazine about food, entertaining, gardening, homekeeping, and crafts. As such, we'd like our version of *Living* to have spoof articles on CDS, dorm decorating, etc. If you'd like to contribute any articles pertaining to the theme (which includes making fun of Martha), any real or fake recipes, and also any pictures that could be applicable, email tammyma@caltech.edu with submissions or for more information. Submissions are due at midnight on Sunday June 6th. Thanks!

Minutes

Continued from Page 4, Column 5

ist prizes available.The deadline for this scholarship is September 16, 2004. Additional information and essay topics are available on their website: *http://www.aynrand.org/contests*.

Key Education Resources is excited to announce the **TAKE 5 Scholarship Offer**! Five lucky winners will win $5,000 each. The scholarship will be offered each month for 5 months. The deadlines for each monthly scholarship and additional information are available on their website: *http://www.Key.com/Take5*.

Sallie Mae has a number of scholarships available: **The Sallie Mae Fund First in My Family Scholarship Program**, The Sallie Mae Fund Unmet Need Scholarship Program, The Sallie Mae Fund American Dream Scholarship Program, and The Sallie Mae 911 Education Fund. In addition The Sallie Mae Fund awards a $1,000 scholarship to a future college student at each of its nationwide "Paying for College" workshops. For a complete listing of 2004 scholarship applications, criteria and deadlines, please visit: *http://www.thesalliemaefund.org*.

Educaid is offering their **"DoubleTake" Sweepstakes**. Win two $2,500 scholarships - One for you and one for your school. Applications are available in the Financial Aid Office, or on Educaid's website: *https://www.educaid.com/doubletake*

Project 257 is a free job referral network for students 16 & older. The goal is to employ dependable students to work in their science/ medical field of interest during the summer of 2004 in colleges all over the country. For more information contact:

Dr. Joe W. Conner, P.I.
Pasadena City College
1570 E. Colorado Blvd., Pasadena, CA 91106
(626) 585-7163

QuestBridge promotes meritocracy in America by uncovering exceptionally talented, self-motivated students from low-income and/or minority communities and linking them with the nation's premier colleges, prep-schools, graduate programs, professional schools, enrichment programs, scholarships, and internships. For more information see the website: *http://www.questbridge.org/index.htm*

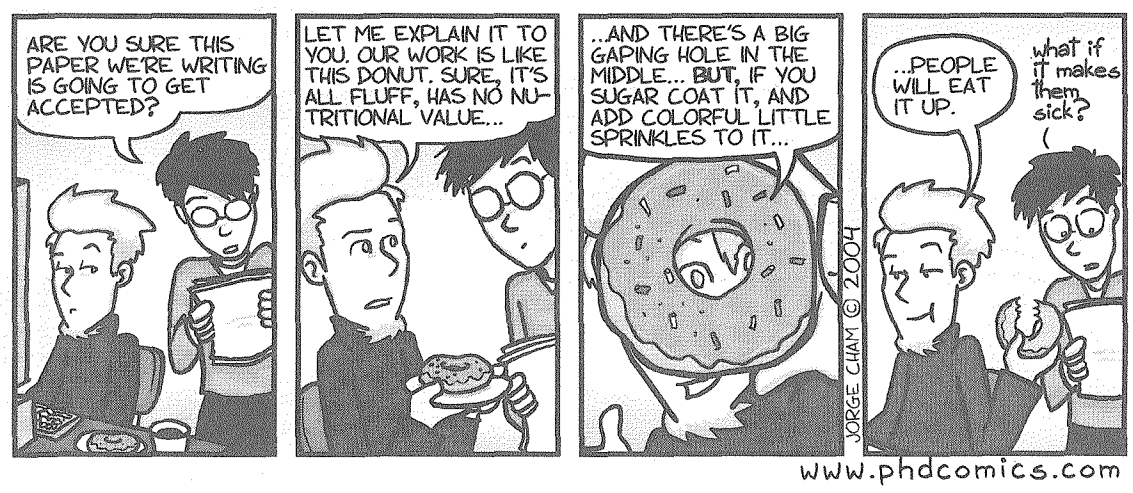
The **John Gyles Education Awards** of $3000 are available to full Canadian or American citizens who are studying all areas of post-secondary study. A minimum GPA of 2.7 is required. Criteria other than strictly academic ability and financial need are considered in the selective process. Filing dates for mailing applications in 2004 are April 1, June 1 and November 15, 2004.

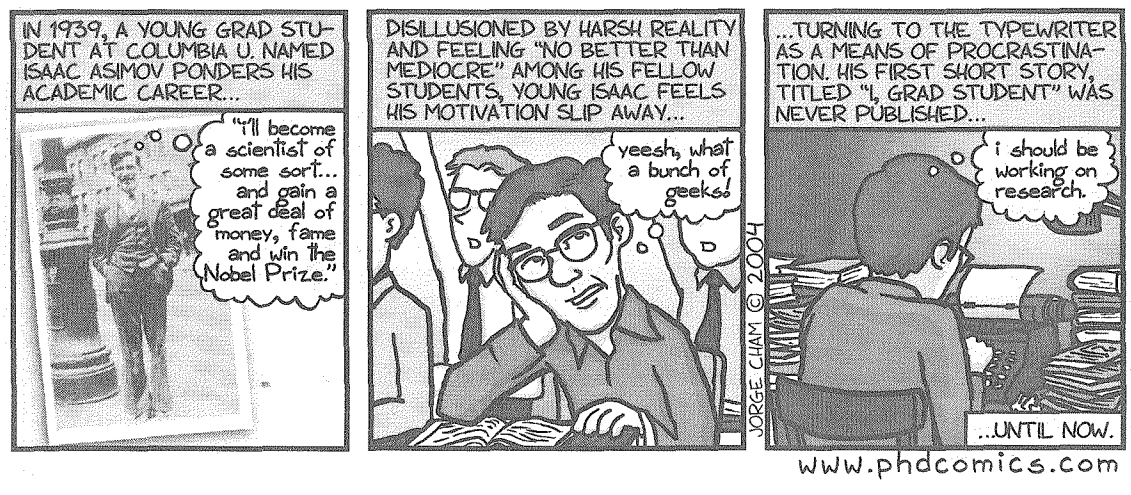
To receive an application, send only a stamped (US 37¢) self-addressed envelope to:

John Gyles Education Awards
Attn: The Secretary
P.O. Box 4808
712 Riverside Drive
Fredericton, New Brunswick
Canada E3B 5GA

If you are a college student who is interested in becoming a naval officer when you graduate, you could apply for the **Baccalaureate Degree Completion Program (BDCP)**. This program pays future naval officers a monthly salary while they are still attending college. Qualified technical majors can receive a salary of approximately $1,500 per month for up to 3 years prior to graduation and qualified non–technical majors can receive this salary for up to 2 years prior to graduation. Additional information is available at: *www.navy.com*.

The National Council of Jewish Women/Los Angeles provides a variety of scholarships year-round for women, regardless of religious belief or ethnic background, who reside in Los Angeles County. The organization focuses on each applicant's dedication to her chosen path and her financial need. Applications are available in the Financial Aid Office. For more information visit: *www.ncjwla.org/*.





Movement Study to Separate Space, Time During Learning

By MARK WHEELER

PASADENA, Calif. - We give little thought to reaching for an object. Should something be in the way, we simply use our arm to go over or around whatever it is to grab whatever we want.

If you think about it, says Elizabeth Torres, a postdoctoral scholar in biology at the California Institute of Technology, it's a remarkable talent. The simple act of reaching and grasping involves a cascade of rapid-fire events.

First, one of our senses, vision, eyeballs the object's location and distance. Next, the brain determines what "degrees of freedom" of the limb are needed to grab it--what angle of the elbow, what rotation of the shoulder, how far to turn the wrist and bend the fingers. Finally comes the determination of the appropriate speed for extending the arm, then stopping precisely at the object's location.

But what's long puzzled neuroscientists like Torres is how the brain translates two different "languages" into action: the sensory cues that come from our vision system--which feeds the brain information about the location, orientation and shape of the object of desire--and the motor execution, the movement of bone and tissue that actually grabs it.

The answer? Geometry, suggests Torres. A transitional, geometric stage between sensory perception and motor actions, in which the brain simulates a task such as grasping an object without actually moving the arm. Her research, which provides further insights into the marvelously complicated workings of the brain, has been published in the May issue of the Journal of Applied Physiology and was selected as a "Highlighted Topic" by the journal.

The conventional wisdom for solving such goal-directed behavior as reaching and grasping has relied on the assumption that the brain has exquisite timing, knowing exactly how long any movement will take before it initiates it. Reaching for a glass of water a foot away takes a certain amount of time at an appropriate speed, a speed different from (way slower than) the speed needed to rescue a glass that's about to tip over.

That assumption about timing came from prior biological motor-control studies and made sense, says Torres, because the data has always come from experiments that use very simple, straightforward reaching movements. In humans, such simple movements are mastered at about the age of seven months. Indeed, such motions become so automatic after a while that the timing for each repetition of the same movement is consistent down to the millisecond.

However, the way in which more complex movements evolve as the system learns to perform them is a different story. In everyday life we are faced with the need to solve new motions all the time. For instance, the familiar and simple task of opening the door to our home requires a new motion if we are carrying a tall stack of books that blocks our view of the door's lock. In that case, the old strategy that would elicit an automatic movement with an exact duration would fail us under the new circumstances.

Torres's approach ignores timing, proposing that during learning, the spatial and the temporal components of the motion can be separated. In her view, the brain first determines a path that, in the case of arm movements, leads the hand along the most optimal direction to solve the task geometrically in a given context.

This means the brain takes into consideration the relationships of other objects to the goal (the telephone in front of the water glass) and the amount of physical space the arm will have to work in. This geometric path is special in that it can be traversed with different timing and still be the same path.

For instance, the straight line between two points in space creates a path that is the shortest distance joining them. This path is unique in that no other path qualifies as the shortest one between these two points. Thus, no matter how one travels along it, fast, slow, or slowing down and speeding up, it is still the shortest path.

Only later, says Torres, does the brain learn how to adjust the timing to best traverse the path. This is analogous to the way in which a dancer learns the choreography of a particular dance, or a musician learns to perform a piece. First, they master the motion that gives the desired outcome and then they adjust the timing of this motion to bring the movement to perfection. Eventually, they become so proficient at it that they can put emotion into it, thus reaching a new level of performance.

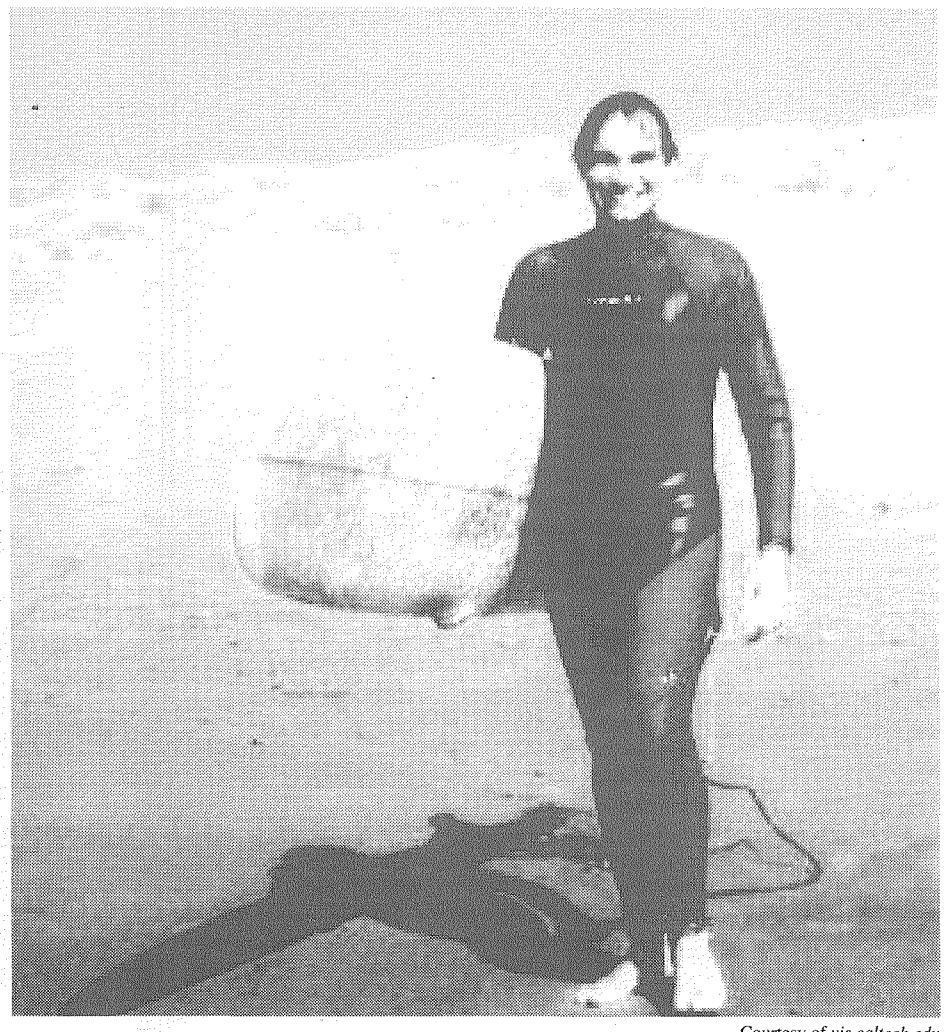
More recently, behavioral data collected in the lab of Caltech's Richard Andersen, the James G. Boswell Professor of Neuroscience, lends support to Torres's theory. The data shows how nonhuman primates learn to avoid obstacles. Indeed there is a clear separation between learning or forming a geometric solution to a particular object and that solution becoming automatic.

Learning consists of forming a geometric strategy, the best path to use in space with respect to a particular set of goals. It becomes an automatic movement only later, when the best time profile is uncovered that best traverses that particular path.

Torres says that without the electrophysiological data from the brain, it's hard to confirm whether this theoretical idea makes sense as a brain solution for learning goal-oriented behaviors. Thus her current research in Andersen's lab focuses on the monitoring of learning and adaptation as they evolve in the non-human primate, in a part of the brain known as the posterior parietal area.

"Dr. Torres is a truly remarkable scientist," says Andersen. "As a graduate student at UCSD she developed a completely novel geometric theory of motor control. She is now testing her theory with experiments here at Caltech and already has results that support her ideas."

"As in a game of chess, through action simulation one can anticipate various outcomes before making a definite move," adds Torres. "Finding evidence in support of this geometric stage, where actions are simulated before actually being executed, would be a first step toward understanding how new motor skills may be acquired all the time."

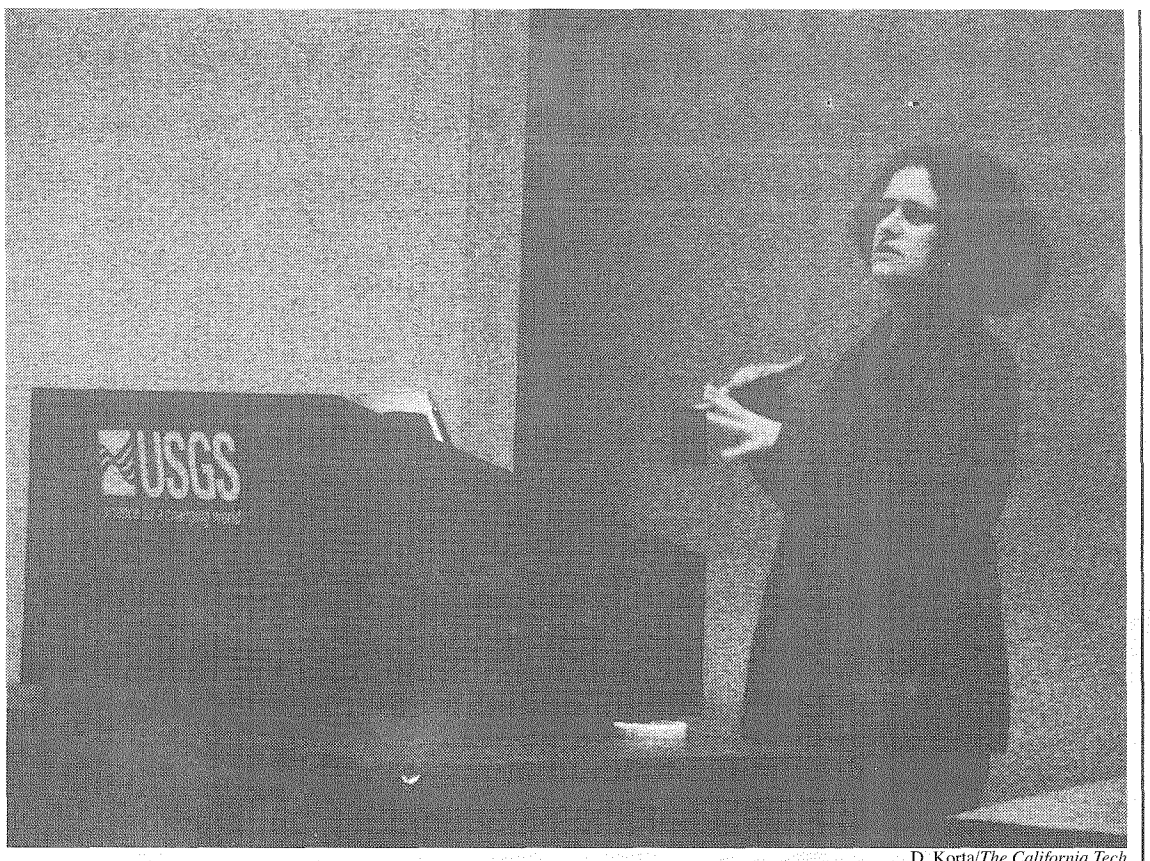


Courtesy of *vis.caltech.edu*

Research in Richard Andersen's lab will study learning and adaptation in the brain of non-human primates.

Courtesy of *vis.caltech.edu*

Dr. Elizabeth Torres developed a theory of motor control as a graduate student and continues her study of movent and the brain here at Caltech.



D. Korta/*The California Tech*

Dr. Hugh explains how she decided to plan and carry out her mapping of California fault lines after being stumped at another lecture.

US Geological Survey Intent On Increasing Earthquake Education

Continued from Page 1, Column 5

neighborhood--or perhaps a ridge such as those in which many luxury homes near Los Angeles are built, may disguise a fault-line where earthquakes have occurred, causing one tectonic plate to overlap or fold under another and thus creating these geological features.

The most memorable part of the evening was Dr. Hugh's use of an analogy of the San Gabriel fault zone to a bulldozer running over a hedgehog to explain the dynamics of the zone. There is an area along the fault where three tectonic plates meet, causing the smallest middle plate to be squeezed between the other two. This causes it to be thrust out, away form the others.

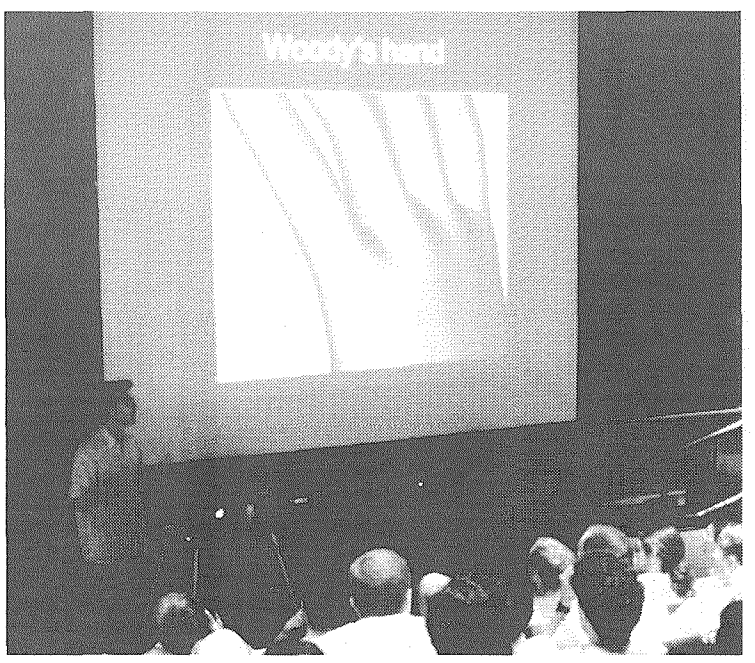
Dr, Hugh likened the situation to a hedgehog being run over by a bulldozer: the hedgehog would be squished and bits would be projected outward, parallel to the plane of the squishing. The illustration this idea was met with some sympathetic groans (in favor of the hedgehog) from the audience, but overall, the image was effective; and likely one that most of the audience members will not forget.

Dr. Hugh also explained her own work in mapping out the fault lines in California for the Unites States Geological Survey. Though not a geologist by training, she proposed the project herself and was granted the funds to do it; she spent a year traveling the California coast, tracing fault lines and mapping them out for benefit of California residents.

Hugh says she was inspired to carry out the project at her first public lecture about earthquakes. When someone asked her where exactly in California the faults she was discussing were located, she realized that, though she knew the general layout of fault lines near the California coast and knew the area quite well, she was not able to see exactly how the two maps of California--that showing its faults and that showing its cities and streets--overlapped.

The project was therefore an attempt to reconcile the two views of California into one coherent map, on which fault lines would be shown, relative to their location near features (like roads and buildings) more recognizable to the non-scientific audience. Hugh showed pictures of sites she visited as part of her survey and even showed pictures of the San Andreas fault taken from a commercial airline jet and mentioned that, if one knows what to look for, one can get quite a kick out of tracing the line of the fault when flying along the California coast.

Dr. Hugh ended her talk with a quotation about the power of earthquakes to create, as well as destroy; the movements of tectonic plates over the earth's surface cause mountain ranges to rise in some regions where the earth is pushed together and create "sink" lakes in places where land is pulled apart. New features are shaped with the destruction of old ones; so that, though earthquakes are a very present danger for residents of California, their power cannot necessarily be considered uniformly bad.



D. Korta/*The California Tech*

DeRosa uses the example of Woody's hand in explaining how Pixar uses touch sensors to render physical models.

Simulators, Lighting Lead to 'Hyperreality'

Continued from Page 1, Column 2

strings the animators will pull to create the story," said DeRose. This determines the ways in which a character walks, talks and moves. During this step, much mathematics and computer science comes into play.

In particular, a method called subdivision surfaces is utilized in order to smooth out rough facets which appear in the model. This method uses linear interpolation to split a facet and then calculates split averages in order to determine where the rest of the points should go. Square matrices then determine how the surfaces will interact. If this subdivision is taken to a limit, the surface would eventually appear smooth.

After articulation, shading further refines the characters by painting their physical images. Set Dressing also creates details for the background locations of the film.

"Then comes layout, when the film really starts to come together," DeRose said. During this step, the shots are put together and the film is handed off to the animators. The animators, who DeRose calls "the actors of the process" determine the time evolution of the virtual strings which control the characters, determining their primary motion, such as their stride and face expressions.

Secondary motion, such as that of cloth or fur, is left for the simulators. In order to create such graphics as fur, simulators often define vector fields on the surface. Effects then handle the animation which does not appear in every shot, such as a snowstorm which may only occur in one scene and lighting generate the light effects.

"There is a lot of cheating in this step. Many of the light effects, like shadows, are not physically in the place where they should be. We're not after reality, we're after hyperreality," said DeRose.

In the future, Pixar is planning to release the feature film "The Incredibles" in 2004 and "Cars" in 2005. Utilizing mathematics and computer programming in innovative and exciting ways, Pixar looks ahead to a bright, successful future in the entertainment industry.

Pixar was established as an independent company in 1986 when it was bought from Lucasfilm by Steve Jobs. It released its first short, *Luxo, Jr.* in that year. *Luxo* went on to win an Academy Award.

Toy Story, Pixar's first full length film, was released in 1995. It was also the first film animated completely by computer and became the highest grossing film of the year. Pixar also had its IPO in 1995.

In total, Pixar employees have been awarded sixteen Academy Awards®. Pixar has also won two Gold Clios for Computer Animation for the Gummi Savers commercial titled "Conga," in 1993 and in 1994 for the Listerine commercial titled "Arrows."

D. Korta/*The California Tech*

An audience member gets to check out the part of the model used to design Woody, a character in Pixar's first full length film, *Toy Story*.

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